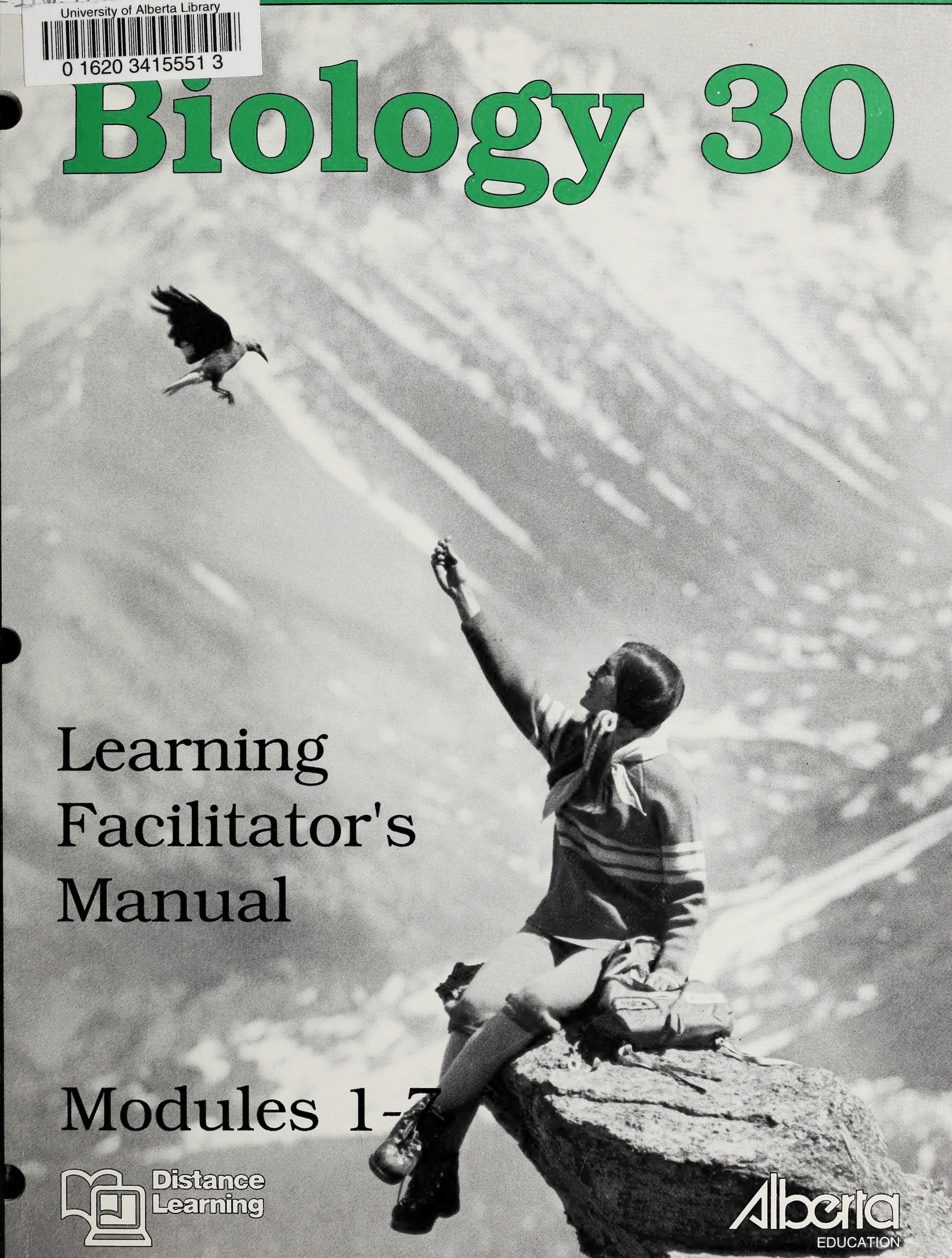
University of Alberta Library
0 1620 3415551 3

Biology 30



Learning Facilitator's Manual

Modules 1-7

Distance Learning

Alberta
EDUCATION

SEP 14 1995

Biology 30

LEARNING FACILITATOR'S MANUAL

Distance Learning

Alberta
EDUCATION

NOTE: This Biology 30 Learning Facilitator's Manual contains answers to teacher-assessed assignments and the final test; therefore, it should be kept secure by the teacher. Students should not have access to these assignments or the final test until they are assigned in a supervised situation. The answers should be stored securely by the teacher at all times.

This document is intended for	
Students	
Teachers (Biology 30)	✓
Administrators	
Parents	
General Public	
Other	

Biology 30
Learning Facilitator's Manual
Modules 1-7
Alberta Distance Learning Centre
ISBN 0-7741-0943-2

ALL RIGHTS RESERVED

Copyright © 1994, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2. All rights reserved. Additional copies may be obtained from the Learning Resources Distributing Centre.

No part of this courseware may be reproduced in any form, including photocopying (unless otherwise indicated), without the written permission of Alberta Education.

Every effort has been made both to provide proper acknowledgement of the original source and to comply with copyright law. If cases are identified where this has not been done, please notify Alberta Education so appropriate corrective action can be taken.

IT IS STRICTLY PROHIBITED TO COPY ANY PART OF THESE MATERIALS UNDER THE TERMS OF A LICENCE FROM A COLLECTIVE OR A LICENSING BODY.

UNIVERSITY LIBRARY

Teachers

Register with the Alberta Distance Learning Centre

The Alberta Distance Learning Centre is dedicated to upgrading and continually improving your Learning Facilitator's Manual so that it accurately reflects any necessary revisions we have had to make in the student assignments or the sample final test. The types of revisions that will be made are those that make the course more accurate, current, or more effective.

The ADLC will send you the **latest enhancements or minor upgrades** for your Learning Facilitator's Manual if you return the following registration card to: Alberta Distance Learning Centre, Box 4000, Barrhead, Alberta, T0G 2P0, Attention: Instructional Design and Development.

ADLC Learning Facilitator's Manual Registration Card

First Name ____________ Surname ____________

School Name ____________ School Phone Number ____________

School Address ____________

City ____________ Postal Code ____________

Course Title ____________ Approximate Date of Purchase ____________

You can help ensure that distance learning courseware is of top quality by letting us know of areas that need to be adjusted. Call the Alberta Distance Learning Centre free of charge by using the RITE line and ask for the Editing Unit. Also, a Teacher Questionnaire has been included at the back of the Learning Facilitator's Manual. Please take a moment to fill this out.

We look forward to hearing from you!

Contents

Introduction 1

Overview of the Program of Studies 3

Overview of Biology 30 5

Structure of the Learning Package 7

Using This Learning Package in the Classroom 10

Evaluation 14

Introducing Students to the System 17

Module 1 19

Module 2 24

Module 3 29

Module 4 35

Module 5 42

Module 6 53

Module 7 60

Answer Key to the Final Test 68

Student's Copy of the Final Test

Teacher Questionnaire

Introduction

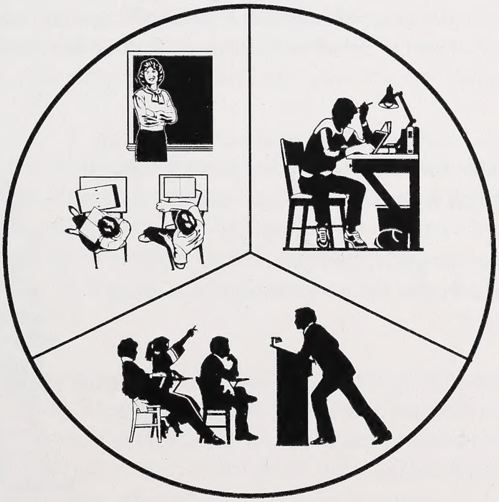
A survey of these course materials will confirm that this new learning package has been specially designed for many kinds of teachers working in a variety of situations.

Which Category Do You Fit?

- ☐ Small Schools Teacher
  - ☐ inexperienced
  - ☐ experienced, but in other subject areas
  - ☐ experienced in teaching high school science, but wanting to try a different approach

- ☐ Distance Learning Teacher
  - ☐ travelling to schools within the jurisdiction
  - ☐ using facsimile and teleconferences to teach students within the area

- ☐ Larger Schools Teacher
  - ☐ inexperienced
  - ☐ experienced in teaching high school science, but wanting to try a different approach



Because these materials have been created by experienced classroom teachers and distance learning specialists, they have many advantages for students and teachers regardless of their situations.

Advantages for Students

- incorporates a strong learner-centred philosophy
- promotes such qualities in the learner as autonomy, independence, and flexibility
- is developed through media which suit the needs and circumstances of the learner
- reflects the experiential background of Alberta students
- opens up opportunities by overcoming barriers that result from geographical location
- promotes individualized learning, allowing learners to work at their own pace

Advantages for Teachers

- allows teachers maximum teaching time and minimizes preparation time
- includes different routes through the materials to suit different learners
- incorporates a wide range of teaching strategies, in particular those using independent and individual learning
- delivers curriculum designed by education specialists that reflects the Alberta Education Program of Studies with an emphasis on Canadian content
- provides learning materials which are upwardly compatible with advanced educational technology

Does it sound like something you could use?

This Learning Facilitator's Manual begins with an overview of the current Alberta Education Program of Studies for Biology 30. This summary is included for inexperienced teachers or those teachers who have found themselves teaching Biology 30 when their training is in other subject areas. This brief summary is not meant to replace the Alberta Education Program of Studies, but rather to help teachers confirm the highlights of the program.

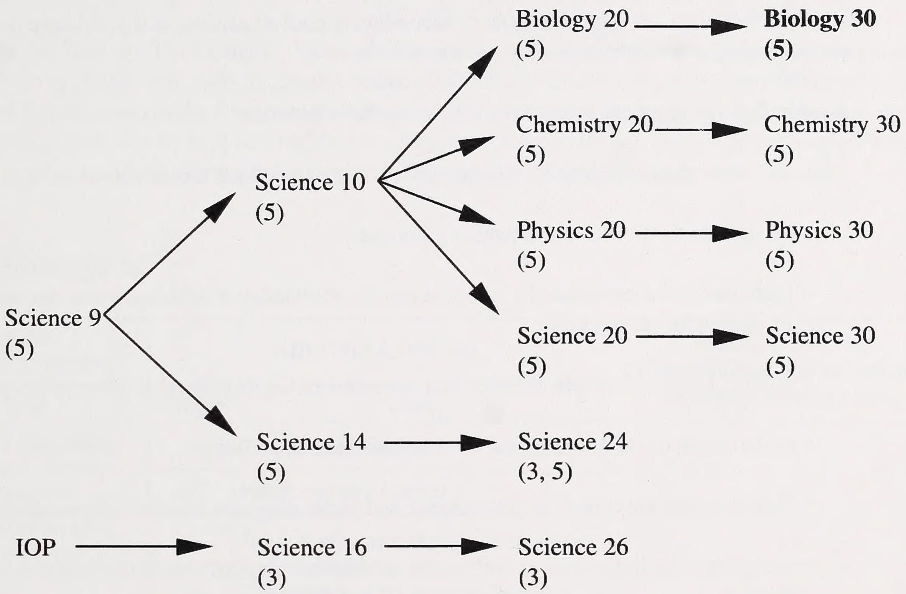
Other parts of this introduction have also been included to help teachers become familiar with this new learning package and determine how they might want to use it in their classroom.

Beyond the introduction the guide itself contains answers, models, explanations, and other tips generated by the teachers who authored this course.

The module booklets and LFMs are the products of experienced classroom teachers and distance learning specialists. It is the hope of these teachers that their experience can be shared with those who want to take advantage of it.

Overview of the Program of Studies

The following diagram illustrates the various course sequences in the Senior High Science Program. Credit values are provided in brackets beneath each of the courses shown on the diagram. Notice that Science 10 is the keystone for the entire Senior High Science Program. Science 10 provides students with the foundation necessary to proceed onto Biology 20, which may be followed by Biology 30.



The Biology 20-30 program emphasizes the key science themes: *energy, matter, change, diversity, systems*, and *equilibrium* as they relate to the biological sciences. These themes provide a means of showing the connections between the units of study in both courses of the program, as well as allowing students to see the nature of the connections to other courses in science. The concepts in biology provide a framework for teachers to show students how individual sections of the program relate to the science themes.

In addition to developing a solid understanding of the fundamental concepts of science and the principles of the biological sciences, Biology 20-30 has the goal of educating students about the nature of science, of technology, and of the interaction between biological sciences and technology. Students must be aware of the tremendous impact of science and technology on society, but at the same time they must be aware of the roles and limitations of biology, science in general, and of technology, in problem solving in a societal context.

The teaching of science using the STS (Science-Technology-Society) approach must centre on the development of scientifically literate and responsible citizens capable of using scientific knowledge wisely for the good of all members of society. The STS approach to science challenges students by developing scientific literacy through experimentation and investigation. This approach motivates students to learn more about science and to apply what they learn to other situations.

Science and technology affect every aspect of the daily life of Canadians. Both science and technology are involved in areas as diverse as communications, travel, agriculture and waste management. But what is science and what is technology? Are they the same or are they different? How do science and technology affect society? How does society control science and technology? If students are to become enlightened, contributing citizens in a constantly changing society they will need to know the answers to these questions.

Scientific literacy is an important goal of secondary school education, as it provides a means for asking and answering some very important questions.

A scientifically literate person has the following characteristics:

- demonstrates a working knowledge and practical understanding of the sciences
- has the ability to evaluate scientific evidence
- understands the processes by which scientific knowledge is developed and can adapt those processes for personal use
- applies science concepts, theories and processes to the investigation of everyday problems
- understands the relationship between science and technology
- demonstrates awareness of how science and technology can function responsibly in a social context
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare
- demonstrates a continuing interest in science and technology.[1]

The Biology 20-30 *Program of Studies* will be an important document for you as a teacher of Biology 30. Once you understand the rationale behind the course and the expectations of students, you'll know how the different components work together, and you'll be able to make better decisions when planning. Starting with the program of studies is a good investment in time. So, before proceeding any further, you should get the most recent version of this document, as well as the Module 1 Student Module Booklet.

To help make the best use of your time, you'll be asked to read certain pages from the *Program of Studies* and then key ideas will be highlighted with supporting examples from the Student Module Booklet. To begin, please read Program Rationale and Philosophy in the *Program of Studies*.

Did you notice the emphasis on students learning the big interconnecting ideas in a relevant context? This philosophy translates into strategies such as providing an equations sheet for students during exams since the focus is not on memorizing equations, but on applying main ideas. Another example can be found on the Overview of the Module 1 Student Module Booklet. Please read this page and note the focus on main ideas being put into a relevant context.

---

[1] Senior High Science Teacher Resource Manual, Curriculum Branch, 1992.

Please read General Learner Expectations in the *Program of Studies*, paying particularly close attention to the section on skills. It could be argued that the skills may be of greater value to the life-long learning of the student than to the specific course content. Clearly, these skills are intended to be a central part of the course. The Student Module Booklet has attempted to make these skills explicit to the students as they progress through the course. Carefully read through the Science Skills at the beginning of Module 1 and *A Framework for Scientific Problem-Solving Skills* in the Appendix of the Module 1 Student Module Booklet.

How should Biology 30 be taught? Although there are a variety of answers to this question, the learning cycle is an approach that many successful science teachers have been using for years. Please read Specific Learner Expectations in the *Program of Studies* to learn more about the learning cycle. Examples of how the learning cycle can be applied to student learning can be found in each section of the Student Module Booklet. Please quickly survey these pages to find evidence of the learning cycle being used.

Overview of Biology 30

BIOLOGY 30 PROGRAM OF STUDIES		ADLC BIOLOGY 30		RECOMMENDED PERCENTAGE OF AVAILABLE INSTRUCTIONAL TIME
Unit	**Title**	**Module**	**Title**	
1	Systems Regulating Change in Human Organisms	1	The Nervous System	10
		2	Hormones and Control	10
2	Reproduction and Development	3	Reproduction and Human Development	15
3	Cells, Chromosomes, and DNA	4	Cell Division and Classical Genetics	20
		5	Heredity and Molecular Genetics	20
4	Change in Populations and Communities	6	Population Dynamics	12
		7	Populations and Communities	13

The following is a description of the units as found in the Program of Studies.

Unit 1 – Systems and Equilibrium: This includes the nervous and endocrine systems. The nervous system is presented as the system that monitors the internal and external environment. It receives, transmits, and integrates information. The endocrine system is presented as a system that adjusts and controls the other systems of the body to maintain homeostasis.

Unit 2 – Systems and Change: This is a study of the human reproductive system and development from fertilization to birth.

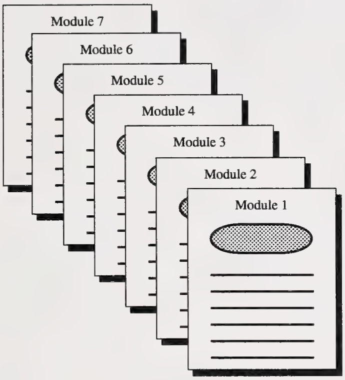
Unit 3 – Cells, Chromosomes, and DNA: This unit begins with cell division, both mitosis and meiosis, and moves on to introductory genetics. The unit progresses through genetics into the principles of heredity, molecular genetics (DNA), and finally protein synthesis.

Unit 4 – Changes in Populations and Communities: This unit is a study of populations as gene pools that interact with each other and their environment and change over time.

Read each of the Overviews for units one to four in the Program of Studies for Biology 30. Notice that Biology 30 is a continuation of the central theme of matter and energy, and systems and equilibrium. Specifically Biology 30 is a study of the nervous, endocrine and human reproductive systems, followed by cell division, genetics and protein synthesis and finally populations and communities to which humans belong. Read the student attitudes that should be developed particularily as described in Unit 4. Bear in mind also that Biology 30 is a Diploma Examination course and the students should be encouraged to treat the main concepts, skills and STS connections seriously.

Structure of the Learning Package

Module Booklets



Contents

Overview
Evaluation

Section 1
Activity 1
Activity 2
etc.
Assignment

Section 2
Activity 1
Activity 2
etc.
Assignment

Section 3
Activity 1
Activity 2
etc.
Assignment

Section 4
Activity 1
Activity 2
etc.
Assignment

Module Summary

The print components involve many booklets called modules. These modules contain guided activities that instruct students in a relevant, realistic setting, as well as assignments that can be used for formative and summative assessments.

The modules have been specially designed to promote such qualities in the learner as autonomy, independence, and flexibility. Writers have incorporated such teaching strategies as working from the concrete to the abstract, linking the old to the new, getting students actively involved, and using advance, intermediate, and post organizers. Many other techniques enable learners to learn on their own for at least some of the time.

The structure of the module booklets follows a systematic design. Each module begins with a detailed table of contents which shows the students all the main steps. It acts as an organizer for students. The overview introduces the module topic or theme. A graphic representation has been included to help visual learners and poor readers. The introduction also states the weightings of each assignment and provides instruction for setting up the response pages that are submitted to the teacher.

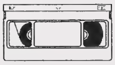
The body of the module is made up of two or more closely related sections. Each section contains student activities that develop skills and knowledge centred around a theme.

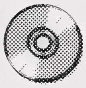
The activities may involve print, audio, video, computer, or laser videodisc formats. At times the student and the learning facilitator are allowed to choose the activity that best suits the student's needs and interests. Other activities such as the Extra Help and Enrichment are optional pathways. This flexibility caters to each student's personal situation.

The summary focuses on the skills and strategies that the student has learned.

The students should complete each section assignment after they have thoroughly reviewed the section. Some modules also have a final module assignment after the Module Summary.

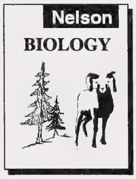
Media


VIDEOCASSETTE


LASER VIDEODISC

The package also includes references to media. Some types of media such as computer disks and laser videodiscs are optional choices for students; however, there are activities that require students to view certain videos. These mandatory videos are listed on the following page. It is important that you acquire these videos as you are planning the course. In addition to the mandatory videos, optional videos have been mentioned at various points in the modules. A list of the optional videos is also included on the following page. More information about the videos can be found within the LFM.

Textbooks and Reference Books



The package requires students to use *Nelson Biology*, published by Nelson Canada, as their textbook. Additional reference materials for teachers are indicated later in this manual.

Lab and Other Materials

The package includes references to lab materials. A list of necessary materials is included later in this manual. A lab kit suitable for individual students is available for purchase from the LRDC.

Materials, Media, and Equipment

Mandatory Components

Equipment (Hardware)	Media	Materials
• VCR	• Mandatory Video List: *Human Body Series: Nervous System* (ACCESS Network) *Organic Evolution: Factoring in Mendel* (ACCESS Network) *Organic Evolution: Meiotic Mix* (ACCESS Network) *Organic Evolution: Population Picture* (ACCESS Network) *Protein Synthesis* (ACCESS Network) *Aspects of Ecology: Populations* (ACCESS Network) *Science Alive: The Spruce and the Hare* (ACCESS Network)	• LFM for Biology 30 • one complete set of module booklets (7) • There is a final test. • Students will also be required to write the Provincial Diploma Examination for Biology 30

Videocassettes or laser videodiscs used in the course may be available from the Learning Resources Distributing Centre or ACCESS Network. You may also wish to call your regional library service for more information.

Using This Learning Package in the Classroom

Conventional Classroom

Whether your classroom has desks in rows or tables in small groups, you may be most comfortable with a learning system that you can use with all your students in a paced style. In other words, you may want a package that will suit all of your students, so they can move through the materials as one group or several small groups. Because these materials contain different routes or pathways within each module, they can address various learning styles and preferences. The materials also include many choices within the activities to cater to different thinking levels and ability levels. Because of their versatility and flexibility, these materials can easily suit a conventional classroom.

Open-Learning Classroom

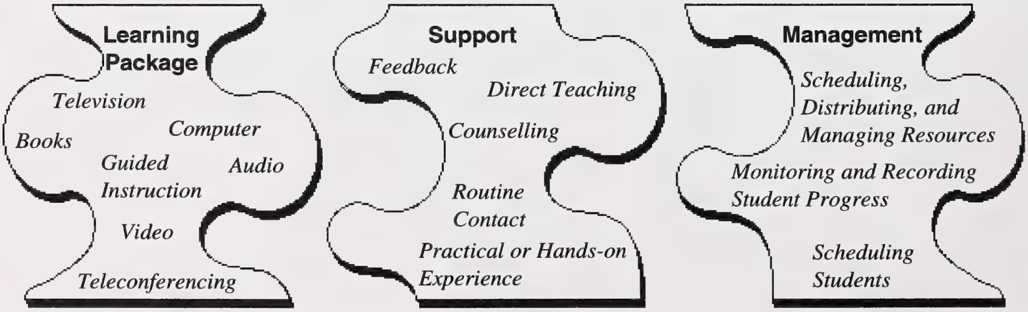
Open learning is the concept of opening up opportunities by overcoming barriers of time, pace, and place by giving the learners a package specially designed to enable them to learn on their own for at least some of the time.

Such a concept is not new. Many teachers can recite attempts to establish an individualized learning system as they recognized the importance of trying to personalize courseware to meet each individual student's needs. But these efforts often failed due to lack of time and lack of quality materials that conformed to Alberta specifications.

Due to advanced educational technology and improved Alberta-specific learning packages, a student-centred approach is now possible. Improved technology now allows us to provide support to learners individually, regardless of their pace or location. A teacher cannot be in twenty-eight places at one time offering guidance. However, media and a well-designed learning package can satisfy individual needs. Technology can also help provide an effective management system needed to track the students as they progress independently through the materials.

The key to a successful open-learning system depends on three vital elements: a learning package specially designed to enable students to learn effectively on their own for at least some of the time; various kinds of learner support; and a management system and style that ensures that the open-learning system runs smoothly.

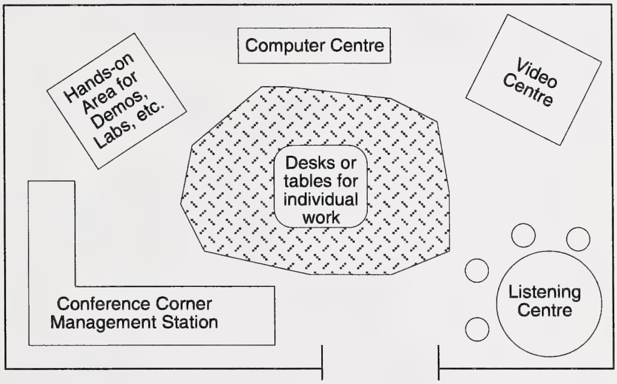
The Key to a Successful Open-Learning System



Learning Package

The specially designed learning package needed for a successful open-learning system has been developed for you. The objectives teach current Alberta specifications using strategies designed for individualized instruction. As the learning facilitator, you need to be sure to have all the components in the learning package available to students as needed.

If adequate numbers of media are available to satisfy the demand, a centre can be established for specific media.


Computer Centre
Hands-on Area for Demos, Labs, etc.
Video Centre
Desks or tables for individual work
Conference Corner Management Station
Listening Centre

You may not have the luxury to have enough hardware to set up a permanent video or computer centre in your classroom. In that case, students should be encouraged to plan ahead. Perhaps every three to five days they should preview their materials and project when they would need a certain piece of media. This would allow you to group students, if necessary, or reserve media as required.

Support

Support is definitely a key element for successful learning, and when you're planning an individualized, non-paced program, you need to carefully plan when and how support will be given.

The materials contain a form of consistent support by providing immediate feedback for activities included in the module booklet. High school students have solutions, models, explanations, and guides included in the appendix of every module booklet. These are included so students can receive immediate feedback to clarify and reinforce their basic understanding before they move on to higher levels of thinking.

As the learning facilitator, you may be needed to offer more personal guidance to those students having difficulty, or you may need to reinforce the need for students to do these activities carefully before attempting the section assignments.

The activities include choices and pathways. If a student is having difficulty, you may need to encourage that student to work on all the choices rather than one. This would provide additional instruction and practice in a variety of ways.

Another form of support is routine contact with each individual. This might be achieved with a biweekly conference scheduled by you, or as students reach a certain point (e.g., after each section is completed), they may be directed to come to the conference area.

Special counselling may be needed to help students through difficult stages. Praise and encouragement are important motivators, particularly for those students who are not used to working independently.

Direct teaching may be needed and scheduled at certain points in the program. This might involve small groups or a large group. It might be used to take advantage of something timely (e.g., election, eclipse, etc.), something prescheduled like the demonstration of a process, or something involving students in a hands-on, practical experience.

Support at a distance might include tutoring by phone, teleconferencing, faxing, or planned visits. These contacts are the lifeline between learners and distance education teachers, so a warm dialogue is essential.

Management

Good management of an open-learning system is essential to the success of the program. The following areas need action to ensure that the system runs smoothly:

- Scheduling, Distributing, and Managing Resources – As discussed earlier, this may require a need for centres or a system for students to project and reserve the necessary resources.

- Scheduling Students – Students and teachers should work together to establish goals, course completion timelines, and daily timelines. Although students may push to continue for long periods of time (e.g., all morning), teachers should discourage this. Concentration, retention, and motivation are improved by taking scheduled breaks.

- Monitoring Student Progress – You will need to record when modules are completed by each student. Your data might also include the projected date of completion if you are using a student contract approach.

Sample of a Student Progress Chart

Biology 30		Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Final Test
Billy Adams	P								
	A								
Louise Despins	P								
	A								
Violet Klaissian	P								
	A								
P = Projected Completion Date A = Actual Completion Date									

The student could keep a personal log as well. Such tracking of data could be stored easily on a computer.

- Recording Student Assessments – You will need to record the marks awarded to each student for work completed in each section assignment. The marks from these assignments will contribute to a portion of the student's final mark. Other criteria may also be added (a special project, effort, attitude, etc.). Whatever the criteria, they should be made clear to all students at the beginning.

Sample of a Student Assessment Chart

Biology 30	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Year's Average	Final Test	Final Mark
Billy Adams	**67**	**65**	**54**	**47**	**78**	**67**	**68**	**64**		
Louise Despins	**43**	**50**	**54**	**55**	**48**	**42**	**57**	**50**		
Violet Klaissian	**65**	**65**	**66**	**68**	**67**	**70**	**69**	**64**		

Letter grading could easily be substituted.

- Recording Effectiveness of System – Keep ongoing records of how the system is working. This will help you in future planning.

Sample of a System Assessment Chart

Module 1			
Date	Activities	Assignments	Resources/Media

The Role of the Teacher in an Open-Learning Classroom

The teachers in a conventional classroom spend a lot of time talking to large groups of learners. The situation in open learning requires a different emphasis. Teachers will probably meet learners individually or in very small groups.

With this approach it is necessary to move beyond the idea of a passive learner depending largely on a continually supportive teacher. The teacher must aim to build the student's confidence, to stimulate the learner into self-reliance, and to guide the learner to take advantage of routes that are most meaningful and applicable to the learner.

These materials are student-centred, not teacher-centred. The teacher needs to facilitate learning by providing general support to the learner.

Evaluation

Evaluation is important to the development of every learner. Data gathering and processing, and decision making, at the student and teacher level, serve as means of identifying strengths and weaknesses.

These specially designed learning packages contain many kinds of informal and formal evaluation.

Observation

In the classroom the teacher has the opportunity to see each student perform every day and to become aware of the level and nature of each student's performance.

Observations are more useful if they are recorded in an organized system. The following list of questions is a sample of types of observations and how they can be collected.

Observation Checklist

	B. Adams	L. Despins	V. Klaissian	H. Smith	K. Dalley
1. Does the student approach the work in a positive manner?					
2. Is the student struggling with the reading level?					
3. Does the student make good use of time?					
4. Does the student apply an appropriate study method?					
5. Can the student use references effectively, etc.?					

Observation may suggest a need for an individual interview with a student.

Individual Conferences

Individual conferences may be paced (scheduled) by the calendar, at certain points in the module, or they may be set up only as needed or requested.

During these conferences teachers can determine the student's progress and can assess the student's attitudes toward the subject, the program, school, and self, as well as the student's relationship with other students. With guided questions the teacher can encourage oral self-assessment; the student can discuss personal strengths or weaknesses in regard to the particular section, module, or subject area.

Self-Appraisal

Self-appraisal helps students recognize their own strengths and weaknesses. Through activities that require self-assessment, students also gain immediate feedback and clarification at early stages in the learning process. Teachers need to promote a responsible attitude toward these self-assessment activities. Becoming effective self-assessors is a crucial part of becoming autonomous learners. By instructing, motivating, providing positive reinforcement, and systematically supervising, the learning facilitator will help students develop a positive attitude toward their own progress.

For variation, students may be paired and peer-assessing may become part of the system. The teacher may decide to have the student self-assess some of the activities, have a peer assess other activities, and become directly involved in assessing the remainder of the activities.

When the activities have been assessed, the student should be directed to make corrections. This should be made clear to students right from the start. It is important to note the correct association between the question and the response to clarify understanding, aid retention, and be of use for study purposes.

Many of the activities include choices for the student. If the student is having difficulty, more practice may be warranted, and the student may need to be encouraged to do more of the choices.

Each section within a module includes additional types of activities called Extra Help and Enrichment. Students are expected to be involved in the decision as to which pathway best suits their needs. They may decide to do both.

Self-appraisal techniques can also be introduced at the individual conferences. Such questions as the following might be included:

- What steps are you taking to improve your understanding of this topic?
- What method of study do you use most?
- How do you organize your material to remember it?
- What steps do you follow when doing an assignment?
- What could you do to become an even better reader?
- Do you have trouble following directions?
- Did you enjoy this module?

A chart or checklist could be used for recording responses.

Informal Evaluation: Assignments

Informal evaluation, such as the assignments included in each module, are an invaluable aid to the teacher. They offer ongoing assessment information about the student's achievement and the behaviour and attitudes that affect that achievement.

Each module contains a number of assignments. These assignments assess the knowledge or skills that the student has gained from the module. **The student's mark for the module may be based solely on the outcome of learning evident in the assignments; however, you may decide to establish a value for other variables such as attitude or effort.** It is important that you establish at the beginning which outcomes will be evaluated, and that all students clearly understand what is expected.

Final Test

All LFMs include a formal final test which can be photocopied for each member of the class. The test, closely linked to the learning outcomes stated in the module booklets, gives the teacher precise information concerning what each student can or cannot do. Answers, explanations, and marking guides are also included. The value of the final test and each module is the decision of the classroom teacher. Following is a suggestion only.

Module 1	**10%**
Module 2	**10%**
Module 3	**10%**
Module 4	**10%**
Module 5	**10%**
Module 6	**10%**
Module 7	**10%**
Final Test	**30%**

Introducing Students to the System

Your initiation to these learning materials began with a basic survey of what was included and how the components varied. This same process should be used with the class. After the materials have been explored, a discussion might include the advantages and the disadvantages of learning independently or in small groups. The roles of the students and teacher should be analysed. The necessary progress checks and rules need to be addressed. Your introduction should motivate students and build a responsible attitude toward learning autonomously.

Skill Level

It is important for students to understand that there are certain skills that they will need in order to deal successfully with the course materials. They are listed below:

- understanding and using instructional materials (table of contents, index, list of illustrations, appendices, bibliography, and glossary)
- interpreting maps, graphs, and charts
- using reference materials
- recognizing special symbols
- using a scientific calculator

Other general skills are using reliable study methods, outlining, and learning to read at a flexible rate.

To decide the level and amount of instruction needed to accommodate the varied levels among students, you may wish to prepare and administer skill inventories or pretests. If most students need help with a particular skill, you may want to plan a total class instructional session. If only certain students lack a skill, you may want to set up a temporary skill group to help students who need it, or you may want to develop a skills file for this purpose.

Reading Level

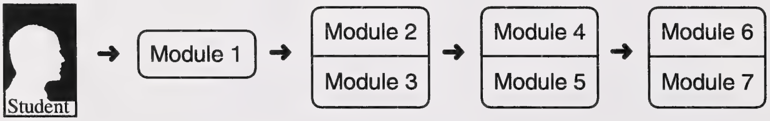
These course materials are largely print based, but poorer readers need not be discouraged. It is important that you assure the students that these materials have been designed for easy reading. The authors have employed special strategies that lower and control the reading level. Some of them are

- the conscious selection of vocabulary and careful structuring of sentences to keep the materials at an independent reading level
- the integration of activities, examples, and illustrations to break text into appropriate-sized chunks
- the inclusion of many kinds of organizers (advance, graphic, intermediate, concept mapping, post organizers) to help give students a structure for incorporating new concepts

- the recognition that vocabulary and concepts are basic to understanding content materials and, thus, must be handled systematically (defined in context, marginal notes, footnotes, and often in a specialized glossary)
- the acknowledgement that background knowledge and experience play a vital role in comprehension
- the systematic inclusion of illustrations and videos to help poorer readers and visual learners, and audiocassettes and software as an alternative to print-based learning
- a variety of formats (paragraphs, lists, charts, etc.) to help poorer readers who do not absorb or retain main ideas easily in paragraph format
- the inclusion of media and activity choices to encourage an active rather than passive approach
- instruction in a meaningful setting rather than in a contrived, workbook style
- using purposeful reading, viewing, and doing to produce better interpretation of the course materials
- the recognition that students need structured experiences when reading, viewing, or listening to instructional materials: developing pupil readiness, determining the purpose, providing guided instruction and feedback, rereading if necessary, and extending (This structure closely resembles the reading process.)

To help make the learning package more readable, you can begin your module preparation by reading (viewing, listening to) all the related materials that are going to be used. You need a solid background in order to assess and develop a background knowledge for students. The students' experiential bases may be assessed through brainstorming sessions concerning the topic, or by using visuals and guided questions to predict what the topic might be about.

It is recommended that you start with Module 1 because this module includes basic introductory information, and it is also recommended that you end with Module 7 because this module acts as a summary or culmination.

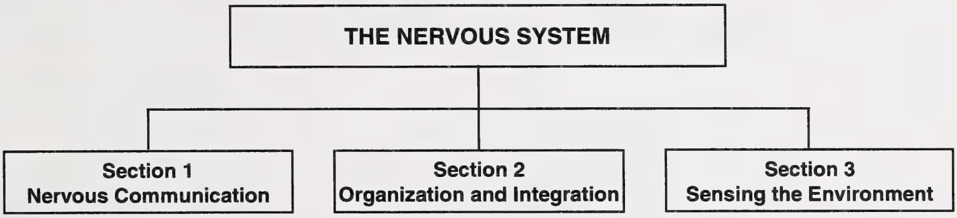


Module 1: The Nervous System

Overview

This module uses the human organism as a model system to study that equilibrium between an organism's internal environment and its external environment can be regulated using electrochemical control. Nerve cell communication processes are studied first. Next, students study the organization of the nervous system and its function. Finally, the detection and integration of sensory information is presented.

It will be important for students to have a clear understanding of the science process skills. In this module careful consideration has been given to the use of investigations that will enhance the development of these skills. The STS connections and attitudes to be encouraged can be reinforced effectively by a learning facilitator. This will prepare students for the Biology 30 Diploma Exam.



Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	**35 marks**
Section 2 Assignment	**30 marks**
Section 3 Assignment	**35 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) **Excellent**	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) **Satisfactory**	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) **Unacceptable**	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of the materials and equipment necessary for an individual to complete the investigations and activities in Module 1.

Section 1: Activity 1

- microslide viewer
- microslide set 221 Nerve and Muscle Action
- rubber reflex hammer
- 30 cm ruler
- penlight

Section 2: Activity 3

- microslide viewer
- microslide set 69 The Central Nervous System

Section 3: Activity 1

- microslide viewer
- microslide set 99 The Senses
- caliper or geometry compass
- 30 cm ruler

Section 3: Activity 2

- Snellen eye chart
- paper cup
- ruler
- pencil
- paper file card
- scissors
- coin

Section 3: Activity 3

- tuning fork
- meter stick
- rubber (reflex) hammer
- swivel chair

Additional Resources

The ADLC Biology 30 course wraps around the Nelson Biology textbook. The Teacher's Resource is designed to help teachers make the most of the textbook. This support includes suggestions, possible journal entries, the use of videodisc, discussion initiations, social issues, cooperative learning, evaluation ideas, and safety tips in the lab. Other helpful resources include the following:

Alberta Education. 1993 *Biology 30 Teacher Resource Manual*. Edmonton Alberta. Department of Education, Curriculum Branch.

Biggs et al. Biology: 1991 *The Dynamics of Life*. Columbus, Ohio: Merrill Publishing Co.

Campbell, Neil A. 1993 *Biology*. Third Edition. Redwood City, California: The Benjamin/Cummings Publishing Company, Inc.

Fox, Stuart Ira. 1990 *Human Physiology*. Third Edition. Dubuque, Iowa: Wm. C. Brown Publishers.

Galbraith, Don. 1993 *Biology Directions*. Toronto, Ontario: John Wiley and Sons.

Guyton, Arthur C. 1991 *Textbook of Medical Physiology*. Eighth Edition. Toronto, Ontario: W.B. Saunders Company.

Hole, John W. 1990 *Human Anatomy and Physiology*. Fifth Edition. Dubuque, Iowa: Wm. C. Brown Publishers.

Philips, WD et al. 1989 *A-Level Biology*. Toronto, Ontario: Oxford University Press.

Ritter, Bob et al. 1993 *Nelson Biology*. Scarborough, Ontario: Nelson Canada.

Ritter, R. and W. Samiroden. 1993 *Nelson Biology Teacher's Resource*. Scarborough Ontario, Nelson Canada.

Wallace, Robert A. et al. 1991 *Biology: The Science of Life*. Third Edition. New York, New York. Harper Collins Publishers Inc.

Possible Media

Videocassettes – ACCESS Network

- BPN – 2634 *The Brain*: 8-part series
- BPN – 259501 *Left Brain, Right Brain*
- BPN – 6028 *Understanding Human Behavior*: 4-part series

Videocassettes – National Geographic

- *The Incredible Human Machine* (1975)
- *The Human Body Series – Nervous System* (1988)

Laser Videodisc – *The Living Textbook: Principles of Biology* can be ordered from Perceptix Inc. (1-800-267-7788)

Note: Some of the suggested media may not be authorized by Alberta Education. Teachers should use their own discretion regarding the use of these resources in their classroom.

Section 1: Nervous Communication

The concepts of polarization, neural transmission, and synaptic transmission are introduced in this section. A review of the cell membrane properties and transport mechanism helps the student. Have the students brainstorm to determine the reflexes a child has from birth. Compare these to a list of learned or conditioned reflexes to start a discussion. You may wish to use a set of dominoes, carefully arranged, to illustrate neural transmission along the membrane. If you can arrange for dominoes to be secured by a spring-loaded hinge to the table, they will stand back up after being knocked over and demonstrate repolarization.

Section 1: Assignment Answer Key (35 marks)

1. A 2. B 3. D 4. D 5. C 6. D 7. B 8. C 9. D 10. B

All multiple choice questions are 1 mark each.

11. Students' response should include a discussion of the following:

a. Students may describe any four of these.

- Photoreceptors in the eye detect the image of the puck.
- Optic nerves relay the impulses to the primary visual cortex of the occipital lobe. At this point students may just say the brain or may describe a reflex action.
- The brain integrates the speed, angle, and distance of the incoming puck.
- Integrated information is sent to the motor neurons leading to the muscles. Students may say the brain generates a motor neuron impulse.
- Motor nerve impulses initiate the muscle contractions that move the arm in response to the shot. **(4 marks)**

b. Students may describe any four of these.

Procedures and equipment can be used in the following ways to improve the goaltender's skill:

- skill training to learn to anticipate direction and speed of shot
- use of contact lenses or glasses to improve vision
- vision training to improve hand-eye coordination
- use of slide projectors, pinlights on a screen, etc.
- muscle training to improve strength and speed of reaction **(4 marks)**

Communication (2 marks)

12. a. The number of nerve impulses initiated in the receptor neuron per second is related to the stimulus strength (units of light energy). Initiation of impulses begins when stimulus strength reaches three units. **(1 mark)**

b. The receptor impulses per second that initiate nerve impulse transmission in neurons 2, 3, and 4 are related in Results II. Neurons 2, 3, and 4 all have different threshold levels. **(1 mark)**

c. A muscle contraction will occur if neuron 3 or 4 reaches its threshold. Therefore, the minimum stimulus would be eight units of light that generates six impulses per second, the threshold for Neuron 3. This causes Muscle Fibre A to contract. **(1 mark)**

d. The receptor will generate five impulses per second. Since the threshold for Neuron 2 is achieved, it will transmit impulses to Neuron 3 and 4. However, the threshold level is not reached in either neuron and no muscle contraction will occur. **(2 marks)**

e. Myelination will speed up impulse transmission. This occurs because the only sites along the membrane that can depolarize are the nodes of Ranvier. The impulses will travel the length of the neuron in less time. **(2 marks)**

13. a. Structure A is a dendrite and Structure E is an axon. The dendrites would be much longer and myelinated in a sensory neuron. The axon would be much shorter in a sensory neuron. **(3 marks)**

b. Structure G is a synaptic vesicle. It releases a neurotransmitter chemical which diffuses across the synaptic gap. Structure H is a receptor site. The neurotransmitter binds to this site and initiates depolarization. **(3 marks)**

c. Structure B is the cell body and functions to receive nerve impulses from its dendrites and transmit the integrated response to its axons. **(2 marks)**

Section 2: Organization and Integration

An excellent way to begin this section is to use a guest speaker – someone who has experienced brain or spinal cord damage. This drives home the message that the nervous system is essential to life. Challenge the students to lower their core body temperature by simply thinking about it. This will help illustrate that there are some bodily functions that are involuntary – at least for most people. Substance abuse is a natural way to initiate the discussion of chemicals and the brain. Again, a guest speaker is an excellent motivator. Asking the students to research certain prescription drugs will help them recognize that abuse is not limited to non-prescription drugs.

Section 2: Assignment Answer Key (30 marks)

1. B 2. C 3. C 4. C 5. A 6. B 7. D 8. A 9. B 10. D

All multiple choice questions are 1 mark each.

11. a. Subject 1 is the most relaxed. **(1 mark)**

b. Any 4 for 4 marks. Students may use paragraph format.

inactive adrenal glands → parasympathetic (normal)
inactive thyroid glands → parasympathetic (normal)
active digestive tract → parasympathetic (normal)
constricted pupils → parasympathetic (normal)
constricted bronchioles → parasympathetic (normal)
slower heart rate → parasympathetic (normal)

The parasympathetic system returns the body to rest. **(4 marks)**

12. a. The sensory neurons in each spinal nerve originate in the skin, so their dendrites transmit sensory information from a specific region. **(1 mark)**

b. Since the dorsal root contains sensory neurons, severing it will produce a loss of sensation from the C7 region, which includes the index and middle fingers, up the arms, and across the shoulders. **(1 mark)**

c. A loss of sensation would occur if there is damage to the dorsal roots of the spinal nerves L5 **(1 mark)** and S1-S2. **(1 mark)** Students may answer L1-L5 and S1-S5 for 2 marks.

d. Spinal nerve T12 will consist of sensory neurons (dorsal root) and motor neurons (ventral root). **(1 mark)** Its functions include sensory information from the skin of the lower chest cavity **(1 mark)** and muscle coordination for the same area. **(1 mark)**

13. Students should compose one or more paragraphs on any two of the following:

- any type of head gear or helmet can be used to protect against blows to the head that may cause brain damage
- use of seat belts has been shown to prevent head injuries which are caused by hitting the windshield with the head
- laws regulating the use of prescription and non-prescription drugs
- drug-testing at athletic events
- educational programs to teach care of the spinal cord **(4 marks; 2 for technology, 2 for communication)**

14. Students' response should include a discussion of the following:

- A is the hypothalamus and it unites the nervous system and the endocrine or hormone system. It functions to control body temperature and emotions.

- B is the pituitary gland which controls the endocrine glands of the body.

- C is pons which serves as a relay station between the cerebellum and the medulla oblongata.

- D is the cerebellum and coordinates muscle contractions to achieve balance and muscle tone.

- E is the corpus callosum and it serves as a bridge between the two cerebral hemispheres relaying information from one side to the other.

- F is the cerebrum and functions in all conscious activity, higher intellectual processes, speech, and personality. **(4 marks)**

Section 3: Sensing the Environment

This section allows students more hands-on experiences. Remember to emphasize that the receptors simply detect stimuli. It is the brain that integrates and "senses" the environment. Sensations are perceptions that students learns to identify. The demonstration on page 382 in the textbook is an excellent way for students to begin a study of receptors. Dissection of a cow or sheep eye graphically illustrates that organ. There are many visual illusions that can be used to show students the impact the brain has on vision. Invite an optometrist to show the students the newest technology in correcting visual discrepancies. To help the students appreciate their sense of hearing, try teaching a class without anyone making sounds. Writing on the blackboard, overhead, or paper and using hand signals are okay. An audiologist can come and test hearing, as well as explain current technologies.

Section 3: Assignment Answer Key (35 marks)

1. D 2. A 3. B 4. C 5. B 6. C 7. B 8. A 9. C

All multiple choice questions are 1 mark each.

10. Students' response should include a discussion of the following:

Concepts (Any 3 → 3 marks)

- The visual perception becomes distorted and the individual "sees" someone in the mirror who is "fat."
- The proprioceptive perception becomes distorted and the individual feels full even though the stomach is empty.
- The olfactory perception becomes distorted and foods take on an unpleasant odour and become undesirable.
- The taste perception becomes distorted and foods lose their savour and the desire to eat decreases.

All of these distortions occur in the brain and do not affect the reception of the stimuli. **(3 marks)**

Communication (2 marks)

11. **Technology** (Any 3 → 3 marks)

- enhancement of sensory perception could include
    - use of stimulants or hallucinogenic drugs
    - vision wear to improve visual reception (microscope, telescope, binoculars, etc.)
    - hearing aids to improve auditory reception (amplification devices, implants, etc.)
    - virtual reality imaging to enhance perception
    - training programs to teach awareness
- disruption of sensory perception could include
    - use of depressants or tranquillizers
    - use of any technology that excludes the perceptions from other senses (cellular telephones in cars, etc.)
    - instruments of war which damage receptors
    - relaxation therapy which trains the individual to ignore sensory perceptions
    - audiovisual presentations (movies, TV, etc.) **(3 marks)**

12. a. The experimenters were testing the relationship between skin temperature and the detection of pain. **(1 mark)**

b. More people feel pain at a skin temperature of 45°C. **(1 mark)** Students may express answers between 44°C and 46°C.

c. Answers will vary, but should include the following:

Reception – People will have different densities of receptors and different thresholds for receptors. **(1 mark)**

Transmission – People will have different numbers of sensory neurons and different amounts of myelination or neurotransmitters. **(1 mark)**

Integration – People will have different experiences in memory and different thresholds in the interneurons, as well as different amounts of endorphins produced. **(1 mark)**

d. Pain-killers can free the individual from suffering, but can become addictive. **(2 marks)**

13. a. The light would come from the top. **(1 mark)**

b. Structure E is the rod. **(1 mark)**
Structures A are the ganglion cells. **(1 mark)**
Structure D is the cone. **(1 mark)**
Structure C is the bipolar cell. **(1 mark)**

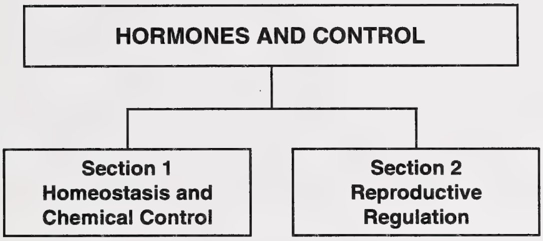
14. a. Group A receptor cells are found in the cochlea. **(1 mark)**
Group B receptor cells are found in the semicircular canals. **(1 mark)**
Group C receptor cells are found in the utricle and saccule. **(1 mark)**

b. Group A receptor cells detect vibrations of perilymph resulting from the transmission of sound waves. The impulses generated are carried on the auditory nerve to the temporal lobe and integrated for sound discrimination. **(1 mark)** Group B and C receptor cells detect acceleration and motion, respectively. The nerve impulses generated are transmitted along the vestibular nerve to the cerebellum and integrated for balance. **(2 marks)**

Module 2: Hormones and Control

Overview

The main focus in this module is the endocrine system and its role in maintaining homeostasis. The module is divided into two sections. The first section consists of six activities. The section deals with the major glands in the body, the major hormones produced by these glands, and their metabolic roles of the hormones. The second section consists of three activities. It examines the endocrine system with respect to reproduction.


HORMONES AND CONTROL
Section 1 Homeostasis and Chemical Control
Section 2 Reproductive Regulation

Evaluation

The evaluation of this module will be based on two assignments:

Section 1 Assignment	**60 marks**
Section 2 Assignment	**40 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of materials and equipment necessary for an individual to complete the investigations and activities in Module 2. Adjust the amount of equipment if more than one individual is involved.

Section 1: Activity 3

- test tube with cap, sterile
- YED agar plate in polystyrene petri dish
- alcohol wipe
- 1 mL pipet, calibrated, individually wrapped
- freshly prepared suspension of G948-1C yeast cells in water
- 1 mL pipets, sterile, calibrated, individually wrapped
- sterile water
- sterile toothpicks
- heavy paper, dark tape, or other lightproof material (not included in the kit) to shade 1/2 plate
- sunscreen, glass microscope slide, sunglasses, or other material to be tested for its ability to absorb UV
- tape

Note: Ward's scientific supply company has the special type of yeast and a write-up of this lab. This lab is also optional in Module 5.

Section 1: Activity 4

- 4 Multistix
- Multistix chart
- 4 test tubes
- corn sugar
- medicine dropper
- distilled water
- 10 mL graduated cylinder
- 2 samples of simulated urine (labelled X, Y)

Note: Multistix are common urinalysis strips. Contact AMES-MILES Scientific Company. Simulated urine is available from Carolina Biological.

Additional Resources

Each of the following resources can provide additional support and information for the teacher of Biology 30. Biology 30 is wrapped around *Nelson Biology*. A teacher's resource manual is available to teachers.

Alberta Education. 1993. *Senior High Science Teacher Resource Manual*. Edmonton: Department of Education, Curriculum Branch.

Campbell, Neil A. 1993. *Biology*. 3rd ed. Don Mills, Ontario: Benjamin Cummings Publishing.
Guyton, Arthur C. 1986. *Textbook of Medical Physiology*. 7th ed. Toronto, Ontario: W.B. Saunders Company.

Wallace, Robert A. 1991. *Biology The Science of Life*. 3rd ed. New York, New York: Harper Collins Publishers.

Media Resources

Laser videodiscs – The *Nelson Biology Teacher's Resource Manual* contains bar codes and frame numbers for reference to the *Living Textbook Principles of Biology* laser videodisc. This videodisc is available from Optical Data Corporation through Perceptix Inc. (1-800-267-7788). See pages 139 to 140 in the Teacher's Resource.

Section 1: Homeostasis and Chemical Control

The emphasis in this section is the endocrine system with respect to the glands, hormones, and their metabolic roles in maintaining homeostasis. Students are to link the nervous system and the endocrine system together and establish their role in maintaining homeostasis. Emphasis is on the neuroendocrine connection especially between the hypothalamus and pituitary gland. As well, students should learn the major glands and be able to identify where each one is in the body. Students are also to learn the metabolic roles of the major hormones. Students should be aware of the nervous and especially endocrine response to stress. This section focuses on the relationship between ultraviolet light, ozone depletion, and pigment deposition within the skin. The focus for the lab activity is for students to play a role in designing an experiment. If students have consciously looked at the scrambled procedural steps they should be able to visualize in their minds what the lab is asking them to do. Students examine glucose metabolism. Emphasize to students the idea of blood glucose or sugar. It is important for students to understand what each of the substances does – glucose, glycogen, glucagon, and insulin. Students must also be able to interpret data and make the proper conclusions. Interpreting graphs and data tables is very important for the student's success in this course.

With regards to the hyperglycemia laboratory activity, it should take no more than twenty minutes to complete. Simulated urine X is normal; Y contains glucose. Corn sugar is used as a simulation of blood glucose. Multistix do not respond to table sugar (sucrose). Interpretation of data is important in this section as well. Students are to infer the role of aldosterone and antidiuretic hormone. Emphasize to students the distinction between these hormones with respect to their stimulation and effect. It can be confusing. The last activity in the section looks at STS concepts as they relate to the endocrine system. Students will learn more about biotechnology when they study the genetics module. The intent here is for students to be aware of this technology, understand the advantage of it, and know examples of hormones produced by this technology.

Section 1: Assignment Answer Key (60 marks)

1. D
2. C
3. A
4. A
5. D
6. B
7. B
8. C
9. D
10. B
11. D
12. A
13. B
14. B
15. D
16. D
17. A
18. D
19. B
20. C

All multiple choice questions are 1 mark each.

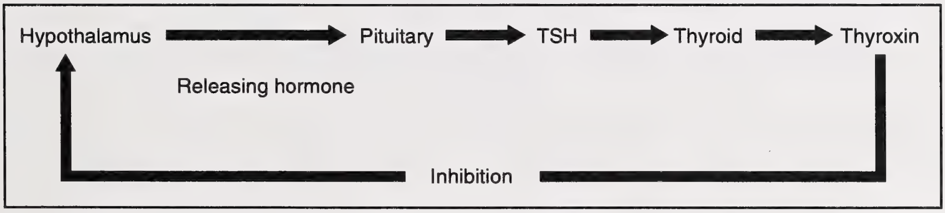
21. a. decrease b. high c. low d. beta e. increase f. medulla g. anterior **(7 marks)**

22. Students must describe and illustrate a negative feedback system involving the hypothalamus-pituitary complex and one other endocrine gland. Give 4 marks for the description, 4 marks for the illustration, and 2 marks for communication.

Description

- identifying the hormone produced by the hypothalamus-pituitary: TSH or ACTH **(1 mark)**
- identifying the target endocrine gland **(1 mark)**
- indicating that the target hormone inhibits secretion of the hypothalamus which inhibits the pituitary gland **(2 marks)**

Illustration



(10 marks)

23. a. thyroxin: Thyroxin regulates the rate at which glucose is utilized in cellular respiration. An increase in thyroxin would cause a decrease in blood glucose level.

or

An increase in metabolism would cause a decrease in glucose. **(2 marks)**

b. insulin: Insulin allows glucose to cross cell membranes from the blood plasma into the cytoplasm of cells. An increase in insulin would cause a decrease in blood glucose level.

or

Insulin stimulates the synthesis of glycogen from glucose in the liver. **(2 marks)**

c. adrenaline: Adrenaline causes the liver to release glucose into the blood stream. An increase in adrenaline will cause an increase in blood glucose level. **(2 marks)**

24. a. The role of ACTH (adrenocorticotropin hormone) is to stimulate the release of melanin from the melanocyte cells. The role of the melanin is to absorb the ultraviolet light before it penetrates deeper into the skin where it can damage melanocytes or other actively dividing cells. **(3 marks)**

b. With greater ozone depletion, there is more ultraviolet light hitting the Earth's surface. Because of the greater amount of ultraviolet light, the chances of skin cancer are increased. **(2 marks)**

25. Low blood pressure in the kidneys or reduced blood flow to the kidneys causes the release of renin which activates angiotensinogen by changing it to angiotensin. Angiotensinogen causes the release of aldosterone from the adrenal cortex. Aldosterone is released into the blood and causes an increased Na^+ reabsorption from the nephron. The Na^+ will increase osmotic pressure of the extracellular fluid and, therefore, increase water reabsorption. **(4 marks)**

26. Hormonal biotechnology involves the use of microbes such as bacteria to produce hormones which are difficult to obtain otherwise. This technology has been used to produce human growth hormone to treat pituitary dwarfism and human insulin which is used to treat diabetes mellitus. Students may give other examples, but their descriptions must include a linkage between technology and the use of an organism to produce a useful product. **(3 marks)**

27. After reaching its peak level, the blood glucose level in the healthy individual rapidly falls as insulin causes glucose to enter cells. The blood glucose level in the untreated diabetic does not fall as rapidly due to a lack of insulin. The more gradual decrease in blood glucose occurs as nerve and blood cells absorb glucose and as glucose is excreted in the urine. **(5 marks)**

Section 2: Reproductive Regulation

This section continues to focus on the endocrine system but from a reproductive perspective. The introductory activity emphasizes the role estrogens and testosterone play in the development of primary and secondary sex characteristics. It should be noted that estrogens are a class of hormones rather than the name of a single hormone. As well in this section, students are asked to interpret data. They must be able to examine data, whether it be a table, graph, picture, or text, and be able to understand the representation of that data.

The menstrual cycle has a number of events occurring in it and there are a number of hormones involved. To improve the learning process, students should first learn the orderly events that take place in the menstrual cycle. It helps to break it down into two cycles – menstrual and ovarian. Once the events are understood, examine the hormones. Establish cause-effect relationships between hormones and other hormones, and hormones and events. It is important to gain a good comprehension of how this cycle works.

This last activity looks at hormonal imbalances and their effects. It discusses the importance of the endocrine system in maintaining homeostasis in the body. The long-term effects of hormone treatments should be emphasized to students.

Section 2: Assignment Answer Key (40 marks)

1.	A	3.	D	5.	C	7.	D	9.	A	11.	C	13.	B	15.	C
2.	B	4.	C	6.	C	8.	D	10.	D	12.	C	14.	C		

All multiple choice questions are 1 mark each.

16. Oral contraceptives primarily contain estrogen and progesterone. Estrogen exerts negative feedback on the hypothalamus and prevents the release of GnRH. Without GnRH, the pituitary will not release FSH and LH. Without FSH, follicles will not develop. Without LH, ovulation will not occur. Progesterone stimulates formation of the endometrium but also inhibits ovulation. **(4 marks)**

17. As shown in the graph, testosterone secretion decreases with age. One of the functions of testosterone secretion is to stimulate the development of male secondary sex characteristics. One characteristic is the increase in muscle strength and mass. This may alleviate the stress on weakening bones and slow osteoporosis. **(3 marks)**

18. The correct order of the statements is c, d, a, e, and b. **(5 marks)**

19. a. LH promotes ovulation. **(1 mark)**

    b. FSH initiates development of the follicle. **(1 mark)**

    c. Estrogen initiates development of the endometrium. **(1 mark)**

    d. Progesterone promotes further development of the endometrium. **(1 mark)**

20. a. The function of GnRH is to stimulate the release of the gonadotropic hormones, FSH and LH, from the anterior pituitary. **(2 marks)**

b. The role of FSH is to stimulate the development of the follicle. **(1 mark)**

c. The peak in LH is due to the rising level of estrogen which increases the secretion of GnRH. **(1 mark)**

d. The peak in LH causes ovulation. It also influences the formation of the corpus luteum. **(1 mark)**

e. During the luteal phase, LH maintains the corpus luteum. **(1 mark)**

f. High levels of estrogen and progesterone inhibit the secretion of LH and FSH. **(1 mark)**

g. Once the corpus luteum disintegrates, estrogen and progesterone levels drop thus removing the inhibition of GnRH. Removal of this inhibition allows LH and FSH levels to increase again. **(2 marks)**

Module 3: Reproduction and Human Development

Overview

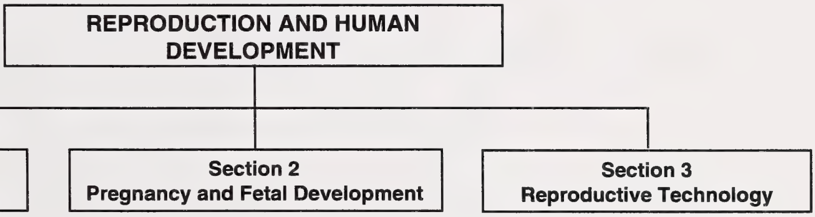
The focus of this module is the structure and function of the human reproductive system. The module covers major concepts 1 and 3 of Unit 2 in the *Biology 30 Program of Studies*. Concept 2 was covered in Module 2.

Concept 1: Humans and other organisms have complex reproductive systems to ensure survival of the species.

Concept 3: Cell differentiation and organism development are regulated by a combination of genetics and environmental influence.

This module is divided into three sections. In Section 1 the student is introduced to male and female anatomy and a brief survey of the major types of STDs. In Section 2 fertilization and development are explored, the STS connection here being problems that can affect the fetus. The module finishes off in Section 3 with an examination of various forms of reproductive technology and their implications.

The textbook is satisfactory in covering the knowledge, skills, and STS connections of concepts 1 and 3 outlined in the Program of Studies. However, there are areas that need supplemental information (i.e., formation of male and female reproductive organs and STDs). These areas have been addressed in this module.



Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	**30 marks**
Section 2 Assignment	**40 marks**
Section 3 Assignment	**30 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of the supplies and equipment necessary to complete the investigations and activities in Module 3. Some investigations are optional. Learning facilitators are advised to examine the investigations prior to acquiring materials.

Section 1: Activity 1

- microslide viewer
- microslide set 62 Reproduction (Human)

Section 1: Activity 2

- microslide viewer
- microslide set 62 Reproduction (Human)

Section 2: Activity 2

- microslide viewer
- microslide set 62 Reproduction (Human)

Resources

The ADLC Biology 30 course wraps around the *Nelson Biology* textbook. The *Teachers Resource Manual* for *Nelson Biology* provides additional ideas to make connections, video laserdisc references, and answers to all questions in the text.

The *Biology 30 Teacher Resource Manual* (1993) by Alberta Education also provides a list of some additional audiovisual materials that can be purchased for this module.

The texts by Wallace (1991), Mariels (1989), and Fox (1990) in the following list provide excellent illustrations of development and anatomy which can be used to supplement *Nelson Biology*.

Additional Resources

Alberta Education. 1993. *Alberta Education Teacher Resource Manual*. Edmonton, Alberta: Department of Education, Curriculum Branch.

Fox, Stuart Ira. 1990. *Human Physiology*. 3rd Edition. Dubuque, Iowa: Wm. C. Brown Publishers.

Guyton, Arthur C. 1991. *Textbook of Medical Physiology*. 8th Edition. Philadelphia: W.B. Saunders Company.

Hale, John W.J. 1990. *Human Anatomy and Physiology*. 5th Edition. Dubuque, Iowa: Wm. C. Brown Publishers.

Mariels, Elaine N. 1989. *Human Anatomy and Physiology*. Redwood City, California: The Benjamin/Cummings Publishing Company.

Ritter, R. and Samiroden, W. 1993. *Teacher's Resource to Nelson Biology*. Scarborough, Ontario: Nelson Canada.

Wallace, R., Sanders, G., and Ferl, R. 1991. *Biology: The Science of Life*. 3rd Edition. New York: Harper Collins Publishers Inc.

Media Resources

- *The Living Textbook* is a laser videodisc available from the following address. Barcodes and frame references may be found in the *Nelson Biology Teacher's Resource*. See pages 166-167.

  Optical Data Corporation
  30 Technology Drive
  Warren, NJ 07059
  USA
  Phone: 1-800-267-7788

- HIV Antibody Test. Information for health care providers. This information package contains pamphlets on the HIV antibody test and on negative and positive test results. From the Public Communications Branch of Alberta Health 427-5541.

- AIDS/STD Information Line 1-800-772-2437

- *We Need to Know About Aids* is a guide for parents on talking to their children about AIDS published by the Minister of National Health and Welfare, 1991. This is a small booklet containing information and suggestions for meaningful discussions.

- *AIDS: The Choices and the Chances* is an informative pamphlet by Alberta Health.

- *Sexually Transmitted Diseases* is a booklet describing the most common STDs: gonorrhea, chlamydia, syphillis, HIV/AIDS, herpes, vaginitis, venereal warts, crabs, and scabies. The information is well organized into sections preceded by general questions. It is available through most Alberta Health Clinics. A Teaching Outline and Resource Guide is available.

  Calgary
  STD Clinic
  Century Building
  319-2nd Ave, S.W.
  Calgary, Alberta
  T2P 0C5
  Phone: 297-6562

  Fort McMurray
  Health Unit
  Jubilee Centre
  9921 Main St.
  Fort McMurray, Alberta
  T9H 4Y5
  Phone: 743-3232

  Education Unit
  Sexually Transmitted Disease Control
  Alberta Health
  4th Floor 10105-109 St.
  Edmonton, Alberta
  T5J 1M8
  Phone: 427-7951/427-2830

- *AIDS in the 90's The New Facts of Life* is an informative pamphlet from Canadian Public Health Association.

  400-1565 Carling Avenue
  Ottawa, Ontario
  K1Z 8R1
  Phone: 613-725-3769

- *We All Need Love – No One Needs Hepatitis B* is an excellent pamphlet from the Canadian Liver Foundation. Class sets may be available. Contact the Foundation by mail or phone.

Canadian Liver Foundation P.O. Box 31024 T5J 4K7
Edmonton Chapter Edmonton, AB 465-1996

Possible Media

There are no mandatory videos for Module 3. The following videos are suggested as enrichment. Other videos may be more current or more local. Review all videos before use in class.

- *Prenatal Diagnosis: To Be or Not To Be* by CBC Nature of Things
- *A New Life* in the *Living Body* series by Films for the Humanities and Sciences Inc. 1-800-252-5126 Box 2053 Princeton N.J. 08543-2053. Call this company toll-free for a catalogue.
- *Into the World* in the *Living Body* series

Note: Some of the suggested media may not be authorized by Alberta Education. Teachers should use their own discretion regarding the use of these resources in their classroom.

Section 1: Males and Females

In this section students will study the structures and functions of the male and female reproductive systems. Anatomy is presented as having a function, the production of sperm and egg, which is followed by the union of these gametes. The role of sex hormones is inferred through initiation and control of development. This links this module back to Module 2. Students should be able to follow the changes in hormones through a menstrual cycle and to interpret responses to fertilization and implantation or to no fertilization. The effect of sexually transmitted diseases on the reproductive systems is explored.

This is a sensitive topic for many students and their parents. Respect for the feelings of sensitive students is a must. Avoid embarrassment by setting a tone. Students must be cautioned not to make fun of anyone's questions. Emphasize individual differences. Puberty begins at different ages and the rates of change are different for each individual.

It is good to use models of male and female anatomy. They give the student a three-dimensional perspective of the position of the internal structures. Microscope slides of sperm and egg cells can be used in place of the microslide viewer. STDs and other disorders of the reproductive system could be covered as a library research assignment. Bring in a public health nurse or doctor to discuss STDs and answer student questions. This could be done in conjunction with Section 3 on reproductive technology.

Section 1: Assignment Answer Key (30 marks)

1. A 2. B 3. D 4. B 5. C 6. B 7. D 8. C 9. D 10. A

All multiple choice questions are 1 mark each.

11. Compare the male and female reproductive systems by completing the following chart. **(5 marks)**

Characteristic	Males	Females
cell produced	sperm	egg (ovum)
name of organ that produces cell	testes	ovary
location of organ that produces cell	external (scrotum)	internal (abdomen)
quantities of cell produced through life	billions	approx. 400 (1 per month)
duration of cell production through life	puberty to 70-80 years of age	puberty to approx. 50 years of age

12. Testicular cancer can result in abnormal sperm production or much decreased sperm production. Prostate cancer can reduce the production of seminal fluid and affect the viability of sperm. Prostate cancer may spread to other organs. Cervical cancer results in the loss of the cervix which makes pregnancy unlikely. Breast cancer should not be accepted since breasts are not part of the female reproductive system. Both prostate and cervical cancer may be life threatening. **(8 marks: 4 for male cancers, 2 for female cancer, and 2 for communication)**

13. STDs may affect reproduction in males by interfering with the passage of sperm through an infected urethra or by reducing sperm production by infecting the testes. Gonorrhea could be an example. In females, STDs may damage and block the Fallopian tubes between the ovary and uterus. Eggs will not be able to reach the uterus. Damage may also occur to the ovary. Cervical cancer associated with an STD such as genital herpes would also affect reproduction. Gonorrhea, chlamydia, herpes and PID could all be examples. **(7 marks: 5 for information, 2 for communication)**

Section 2: Pregnancy and Fetal Development

In this section students follow the events leading to fertilization, implantation, and growth. The formation and role of the placenta is discussed and should be linked to changes in hormones and the menstrual cycle. Embryonic and fetal development is described through the trimesters, but detail is limited to major physiological events. A teacher may wish to provide more detail with teaching aids such as media, models, or guest speakers. Changes in fetal development in response to drugs can be explored here. Problems of Rh incompatibility between fetus and mother are described.

Use the textbooks from the additional resources list to find more pictures that illustrate more of the changes throughout fetal development (make overhead transparencies). Fetal development models make a good demonstration of development. They often can be borrowed from local hospitals or organizations. Have students make charts showing stages of development of the embryo and fetus. Additional reference materials may be necessary.

The videos *A New Life* and *Into the World* are suggested here. **Please note**: It may take over one month's time to receive videos from the United States. Check preview policy before ordering. Local sources such as prenatal programs may have more available material.

Section 2: Assignment Answer Key (40 marks)

1. C 2. D 3. D 4. C 5. B 6. A 7. C 8. D 9. C 10. B

All multiple choice questions are 1 mark each.

11. The placenta grows out of a part of the chorionic membrane of the blastocyst. The placenta also grows out of part of the endometrium of the mother's uterus. Waste from the fetus (CO_2 and nitrogenous wastes) are brought to the placenta and diffuse from the fetal blood into the maternal blood. Nutrients and oxygen from the maternal blood diffuse into the fetal blood at the placenta. **(6 marks)**

12. **Textbook question 4**: Hormones necessary for sperm production are present in both mice because the blood streams are connected. The pituitary gland in Mouse A produces LH and FSH for both mice. The testes in Mouse B produce testosterone for both mice. Only Mouse B responds to these hormones by producing sperm. Mouse A will not produce sperm because its testes have been removed. **(4 marks)**

13. a. The manipulated variable is the age of fetus. **(1 mark)**

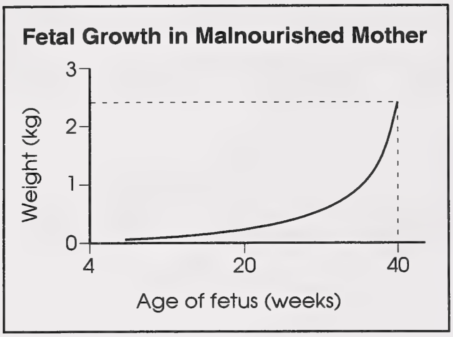
    b. Two responding variables could be any two of the following:

    - calcium stored
    - phosphorus stored
    - iron stored **(2 marks)**

    c. Two controlled variables are health of the mother and diet of the mother. **(2 marks)**

    d. At around sixteen weeks bone development begins and continues until birth. **(1 mark)**

    e. At forty weeks birth occurs. **(1 mark)** f.



(At forty weeks the line should be between 2-3 kg.)

(3 marks: 1 mark for graph (proper axis), 1 mark for line, 1 mark for title and axis labelled with units.)

Students should illustrate a slower weight gain during development and at birth in the graph.

14. Concepts **(5 marks)**
Factors that affect development **(3 marks)**
Communication **(2 marks)**

The concepts should include the following:

Conception – union of sperm and egg in Fallopian tube
Implantation – attachment of blastocyst to uterus
Development – growth of all body systems from embryo to fetus
Parturition – drop in progesterone and increase in oxytocin causing uterine contractions
Lactation – production of prolactin to stimulate milk production in breasts to feed baby

The factors that could affect the development of the fetus include the following:

Rh incompatibility – Rh^- mother and Rh^+ fetus
Fetal Alcohol Syndrome – causing growth problems and fetal addiction
Drug abuse – causing growth problems and fetal addiction

Section 3: Reproductive Technology

This section deals with physiology and mechanical basis of various reproductive technologies. This is a very controversial issue. Try to have the students examine advantages and disadvantages to all technologies examined. Coverage is not comprehensive as advances in these technologies are constantly occurring. Students should become familiar with the more common methods of fetal investigation such as amniocentesis and ultrasound. Genetic determination will be covered in Modules 4 and 5 by examination of karyotypes. Ethical considerations and issues may be explored at the discretion of the teacher and school system. A collection of readings and a study guide entitled *Topics in Bioethics for Science and Religion Teachers* may help teachers and students in discussions of genetic engineering, new reproductive technology, euthanasia, and organ and tissue transplants. This publication is available from the following address:

Science – Educational Services
Edmonton Catholic Schools
Administration Centre
9807-106 Street
Edmonton, Alberta
T5K 1C2
Phone: (403) 441-6109

Talk to the C.A.L.M. Teachers to determine the depth of coverage of birth control in their course. Use a public health nurse or doctor as a guest speaker (see Section 1). This topic could be covered as a research paper. Collect articles from magazines and newspapers about amniocentesis, ultrasound, or any other new technology. Pin these up on a bulletin board in class under a heading "New Technology." This could be ongoing with the other modules.

Section 3: Assignment Answer Key (30 marks)

1. B 2. C 3. A 4. C 5. C

All multiple choice questions are 1 mark each.

6. a. Two manipulated variables are the type of birth control used and urban versus rural areas. **(2 marks)**

   b. The responding variable is the percentage of couples using various methods. **(1 mark)**

   c. Students may describe any two: **(2 marks)**

   - The couples questioned may have been only using one form of birth control or they may have not been practising consistently or they could have switched methods.
   - Age group, age of couples, and number of children would have to be standardized or controlled.

   d. Tubal ligation showed the greatest rural/urban discrepancy. **(1 mark)**

   e. This method requires a surgical procedure, more difficult than a vasectomy; therefore, access to this may be better in a city than outside the city. Students may suggest other answers, ie., socioeconomic reasons. **(1 mark)**

   f. The birth rates would be higher in rural areas than in urban areas. **(1 mark)**

   g. The couples in rural areas may not have as easy an access to birth control or to education about birth control as do couples in an urban setting. Birth control may not be as desirable in rural China. Rural people may want to have more children. Students may compose other reasons. **(2 marks)**

7. At puberty the hypothalamus releases gonadotropin releasing hormone (GnRH). This causes the pituitary to release FSH and LH. These hormones travel to the ovary and stimulate development of a follicle. As the follicle grows it secretes estrogen which initiates growth of the endometrium. Estrogen also inhibits further secretion of FSH and increases secretion of LH. LH causes ovulation. After ovulation the follicle becomes a corpus luteum and secretes progesterone and more estrogen. These hormones encourage further development of the endometrium and inhibit contractions of the uterus. Assuming fertilization occurs, implantation follows. Human chorionic gonadotropin (HCG) is secreted by the outer layer of cells around the embryo and maintains the corpus luteum. The corpus luteum continues to produce estrogen and progesterone to maintain the endometrium. This maintains the embryo in the uterus. The outer embryonic membrane (chorionic villi) and endometrium combine to form the placenta.

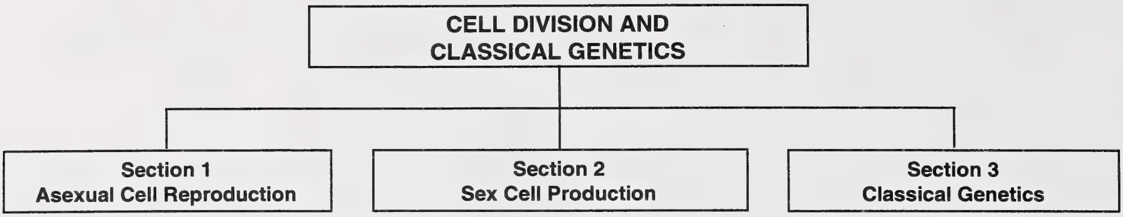
Event	Site	Hormone
Puberty	hypothalamus	GnRH
Oogenesis	pituitary	FSH, LH
Ovulation	corpus luteum	estrogen, progesterone
Implantation	embryo	HCG

(15 marks: 10 for information, 3 for table, 2 for communication)

Module 4: Cell Division and Classical Genetics

Overview

The focus of this module is on the importance of a controlled process of cell division to create new cells or to create gametes. Cell division (mitosis) is presented as a method of making exact copies of cells for growth and repair of tissues. Meiosis is studied as cell division that creates gametes with only half the normal genetic material requiring fertilization to restore a complete compliment before life can continue. Classical genetics is introduced through the consequences of meiosis and fertilization.


CELL DIVISION AND CLASSICAL GENETICS
Section 1 Asexual Cell Reproduction
Section 2 Sex Cell Production
Section 3 Classical Genetics

Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	**30 marks**
Section 2 Assignment	**30 marks**
Section 3 Assignment	**40 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of materials and equipment necessary for a student to complete the activities and investigations in Module 4.

Section 1: Activity 1 – Part A

- microscope
- prepared slides of onion root tip
- prepared slides of whitefish blastula
- unlined paper
- graph paper
- ruler and pencil
- lens paper

Section 1: Activity 1 – Part B

- microslide set #55 Plant Mitosis
- microslide viewer
- graph paper
- unlined paper
- pencil

Section 1: Activity 2 – Part A

- light microscope
- prepared slide of squamous cell carcinoma
- unlined paper and pencil
- ruler
- lens paper

Section 1: Activity 2 – Part B

- photograph of normal human karyotype
- photograph of a human cancerous cell karyotype

Section 2: Activity 1

- 2 sheets of blank paper
- pencil
- ruler
- 4 paper clips
- 10 cm strands of red yarn (4)
- 5 cm strands of red yarn (4)
- 10 cm strands of blue yarn (4)
- 5 cm strands of blue yarn (4)

Section 2: Activity 3

- Human Karyotype Plate A (found in the Appendix)
- scissors
- blank paper
- transparent tape

See Lab 29 in *Biology: A Canadian Laboratory Manual*

Section 2: Enrichment

- Human Karyotype Plate B (found in the Appendix)

See Lab 29 in *Biology: A Canadian Laboratory Manual*

Section 3: Activity 4

- two coins
- small cup
- paper and pencil

Section 3: Enrichment

- pencil and paper

See Lab 27 in *Biology: A Canadian Laboratory Manual.*

Additional Resources

Ritter, R., Drysdale, B., and Coombs, D. 1987. *Biology: A Canadian Laboratory Manual.* Agincourt, Ontario: GLC Silver Burdett Publishers.

Ritter, R. and Samiroden, W. 1993. *Teacher's Resource to Nelson Biology.* Scarborough, Ontario: Nelson Canada.

Media Resources

Videocassette – Organic Evolution: *Meiotic Mix* ACCESS Network 289504

Videocassette – *Organic Evolution: Factoring in Mendel* ACCESS Network 289503

Laser videodiscs – The *Teacher's Resource to Nelson Biology* contains bar codes and frame numbers for reference to the *Living Textbook Principles of Biology* laser videodisc. This videodisc is available from Optical Data Corporation through Perceptix Inc. (1-800-267-7788). See pages 174 to 184 and pages 206 and 207 in the *Teacher's Resource to Nelson Biology*.

Section 1: Asexual Cell Reproduction

Asexual cell division should be approached from a general perspective with a view of its function in the body and how it fits into the general cell cycle. It should be pointed out that mitosis also leads to reproduction of single-celled organisms, a process called binary fission. The text uses the term *mitosis* in two different ways. It refers to mitosis as a division of nuclear material in one case and division of body cells in another. The latter definition should be avoided.

The major hurdle of normal cell division is to replicate the genetic material in the nucleus and to then pass on a complete set of this DNA to each of the daughter cells. At this point, students have not covered DNA structure and replication and so must approach replication in a more general sense. It should be made clear that once a chromosome replicates, the two replicas are called chromatids until they are pulled apart in anaphase. The main focus of the entire process should be on the action of the chromosomes as they are separated. The other details of each phase are to be covered but they are almost incidental. Be sure to point out the differences between mitosis of plant and animal cells.

Section 1: Assignment Answer Key (30 marks)

1. B 2. B 3. C 4. D 5. D 6. A 7. B 8. B 9. B 10. A

All multiple choice questions are 1 mark each.

11. a. telophase b. interphase c. anaphase d. metaphase e. interphase **(5 marks)**

12. The correct order is d-prophase; e-metaphase; a-anaphase; c-telophase; b-interphase. **(5 marks)**

Note: Students could order slides b-d-e-a-c.

13. Fraternal twins originate from two different egg cells produced at the same time. These eggs are fertilized by different sperm; thus, the twins are as different genetically as any two siblings born at different times. **(2 marks)**

14. The paragraph should include four of the following points:

Cancer cells have the following differences from normal cells.

- Cancer cells are capable of dividing in isolation, whereas normal cells need cell-to-cell contact and communication.
- Cancer cells do not adhere to each other very well, whereas normal cells do. This leads to metastasis of cancer cells.
- Cancer cells do not differentiate; thus, they do not change shape. Normal cells do.
- Cancer cells show rapid uncontrolled mitosis; normal cells have a controlled slower rate of division.
- Cancer cells may have abnormal chromosome counts; normal cells generally do not. This may include missing chromosomes, extra chromosomes, or translocation of parts of chromosomes. **(4 marks)**

15. a. This cell contains fifty-five chromosomes.

b. Trisomy exists for chromosomes 1, 6, 8, 11, 17, 18, 19, 21, and 22.

c. Chromosome 13 shows tetraploid *Y*.

d. Chromosome 20 and the Y chromosome are missing. **(4 marks)**

Section 2: Sex Cell Production

This type of cell division should be introduced from the perspective of function. Point out that when sexual reproduction occurs the resulting offspring always end up with the same number of chromosomes as the parents have in their cells rather than double that amount. How does this happen? Lead the students to the observation that there must be a halving of the chromosome number in the making of gametes, so that each gamete contributes half the normal number of chromosomes found in body cells. Begin by explaining that complex organisms are diploid, that chromosomes come in pairs, and that the number of chromosome pairs varies from species to species. It is critical to do a good job of explaining homologous chromosomes because these are significant in reduction division. Now define a set of chromosomes as a collection of one of each kind of chromosome normally present in the cells of the organism. Making reference to chromosome sets from this point on will make it easier to deal with differences between meiosis and mitosis later.

To explain reduction division you may want go through meiosis without replicating the chromosomes. This simplifies meiosis I so that reduction becomes much more evident. Then you can go back and tell the students that replication of chromosomes had taken place initially so the process is more complicated than what first appeared. Because of replication a second division is necessary and that is why you get four haploid cells instead of two.

Nondisjunction occurs in both meiosis I and meiosis II. This should be made clear to students. There are not very many chromosomal aberrations that are viable, which shows the importance of keeping the chromosome count at a fixed species number, particularly in humans. In plants, this is not the case as you see with polyploid species.

When dealing with life cycles, the focus should be on how organisms make use of mitosis and meiosis in the perpetuation of the species. Avoid excessive detail of parts and their names for any one species discussed.

Section 2: Assignment Answer Key (30 marks)

1. C   2. D   3. A   4. B   5. D   6. B   7. A   8. C   9. C   10. C

All multiple choice questions are 1 mark each.

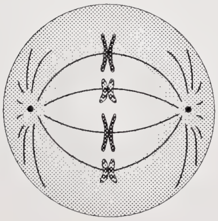
11. This individual has forty-six chromosomes which is a normal number but the makeup of chromosomes is abnormal. There are three number 18 chromosomes, which would cause Edward syndrome, and only a single X chromosome, which would cause Turner syndrome. The individual would be female having one X chromosome and no Y chromosome. Both Edward and Turner syndrome result from nondisjunction. Either the sperm or egg carried two number 18 chromosomes and lacked a sex chromosome prior to fertilization. **(6 marks)**

12. a. Plant A undergoes sexual reproduction. **(1 mark)**

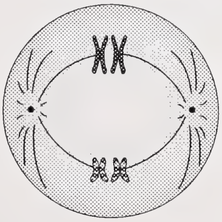
b. The sporophyte stage begins with Plant B which is diploid. This plant produces haploid spores, which are characteristic of the phase of alternation of generation in plants, by meiosis. **(2 marks)**

c. Plant A would become the apples of an apple tree because an apple starts from a flower which forms gametes and eventually a zygote or seed. **(2 marks)**

13. a. Mitotic metaphase



Metaphase I of meiosis



(2 marks)

b. In mitotic metaphase each chromosome composed of two chromatids acts independently, lining up on the equatorial plate. This alignment produces two cells genetically identical to the original mother cell. In metaphase I the homologous chromosomes come together and line up as tetrads. This arrangement leads to reduction of the chromosomes from the diploid number to the haploid number. **(1 mark)**

14. This process serves to produce new combinations of genes, thus producing new combinations of traits which add to individual variation among members of a species. **(1 mark)**

15. a. Section C. This causes only one cell to become a functional egg. The other is lost as a polar body. This occurs again in Section D. **(2 marks)**

b. 30 chromosomes **(1 mark)**

c. Section C. **(1 mark)**

d. Section D. **(1 mark)**

Section 3: Classical Genetics

The term *factor* is used to start with to give this section an historical flavour and eventually the term becomes interchanged with *gene*. When dealing with dominant and recessive alleles do not suggest that the dominant trait is always the preferred trait. There are many recessive traits that are advantageous. Huntington's disease, six fingers, and dwarfism are all produced by dominant alleles. To differentiate between gametes and genotypes represent the gamete with a circle, a larger one for the egg and a smaller flagellated one for the male sperm. This helps students to follow the transfer of alleles from parents to the offspring and to place the gametes correctly on the Punnett square. Be consistent in this respect, female gametes are along the top and male gametes are along the side of the square. Do not repeat gametes on the Punnett square, only show one of each kind. This then will make the square variable in the number of subsquares. To make independent assortment more meaningful for students, place two pairs of alleles on two different homologous chromosomes and show how these can align on the equatorial plate to produce four different combinations of genes. Students have difficulty visualizing this since it is an abstract concept. Students may also have trouble with the terms *genotype* and *phenotype*. These, along with other terminology, should be used at all times to get students accustomed to the language of genetics.

Section 3: Assignment Answer Key (40 marks)

1. D
2. B
3. A
4. D
5. A
6. D
7. C
8. A
9. A
10. C
11. C
12. C
13. B
14. C
15. C

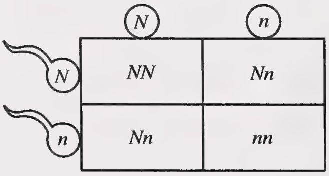
All multiple choice questions are 1 mark each.

16. a. alleles
b. genotype
c. homozygous
d. phenotype
e. codominance **(5 marks)**

17. a. Normal feathers are controlled by a dominant gene. **(1 mark)**

b. F$_1$ genotype = *Nn*
Nn × *Nn*

F$_2$ genotypes = *NN*, *Nn*, and *nn*
F$_2$ phenotypes = normal and silky



	N	*n*
N	*NN*	*Nn*
n	*Nn*	*nn*

(1 mark)

c. The phenotype ratio in the F$_2$ generation would be 3 normal feathers: 1 silky feather or 3:1 dominant/recessive. **(1 mark)**

d. i. 1/4 of 200 = 50 birds
   ii. 1/4 of 200 = 50 birds
   iii. 3/4 of 200 = 150 birds **(3 marks)**

18. You would cross the straight-winged fly with a curly-winged fly. If all the offspring produced are straight-winged, then the straight-winged fly is homozygous. If some of the offspring show curly wings, then the fly must be heterozygous. **(1 mark)**

19. **Mating 1** Polled bull *Hh* × Horned cow *hh*

hh
Horned calf

Mating 2 Polled bull *Hh* × polled cow *Hh*

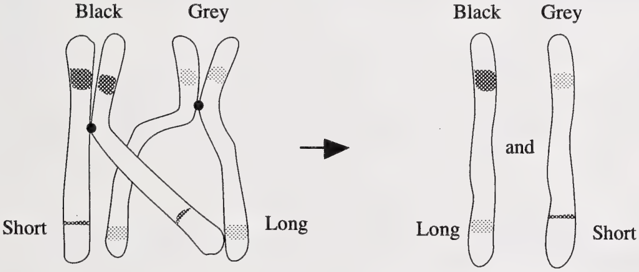
hh
Horned calf

The genotype of the bull is *Hh*. **(1 mark)**
The genotype of the horned cow is *hh*. **(1 mark)**
The genotype of the polled cow is *Hh*. **(1 mark)**

20. a. The alleles for width of leaves show incomplete dominance producing a blend of the two phenotypes. **(1 mark)**

b. There would be three phenotypes. **(1 mark)**

21. Crossing-over must occur causing the formation of chromosomes carrying black and long wing genes and grey and short wing genes. **(2 marks)**



New combinations

22. A black long × white short cross gives four phenotypes; thus, the parents cannot be homozygous for the dominant trait in each case.

a. The following are the most likely genotypes for the parent:

- black long = *Bbss*
- white short = *bbSs* **(2 marks)**

b. The possible genotypes for the offspring would be

	Bs	*bs*
bS	*BbSs*	*bbSs*
bs	*Bbss*	*bbss*

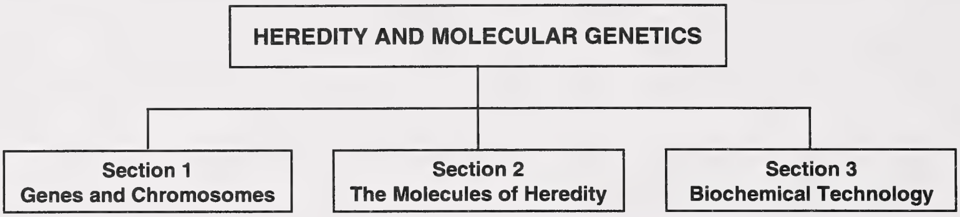
(2 marks)

c. The theoretical phenotypic ratio should be 1:1:1:1 or $\frac{1}{4}:\frac{1}{4}:\frac{1}{4}:\frac{1}{4}$. **(1 mark)**

Module 5: Heredity and Molecular Genetics

Overview

In this module classical genetics is extended to a molecular level where the role of DNA in producing proteins is presented. The principles of introducing change into a sequence of bases in DNA is examined. First, the student studies the genetic code found within DNA. Then the application of this genetic information in normal and abnormal situations is reviewed.



It will be important for students to have a clear understanding of the science process skills. In this module careful consideration has been given to the use of investigations that will enhance the development of these skills. The STS connections and attitudes to be encouraged can be reinforced effectively by a learning facilitator. This will help prepare the student for the Biology 30 Diploma Exam.

Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	**40 marks**
Section 2 Assignment	**40 marks**
Section 3 Assignment	**20 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of materials and equipment necessary for an individual to complete the investigations and activities in Module 5. Some investigations are optional. Learning facilitators are advised to examine the investigations prior to acquiring materials.

Section 1: Activity 1

- colour blindness chart See page 502 in *Nelson Biology* text.

Section 2: Activity 1

- pencil

Section 2: Activity 1

- scissors
- transparent tape
- page of symbols for DNA See *Nelson Biology Teacher's Resource*, page 220. Also see tear-out sheet in Appendix.
- toothpicks
- blank sheet of paper

Section 2: Activity 2

- scissors
- transparent tape
- page of symbols. See tear-out sheet in Appendix.
- toothpicks
- blank sheet of paper

Section 3: Activity 1

- incubator or warm, dark, moist location
- prepared suspension of G948-1C yeast cells in water
- sterile water
- YED agar plate in petri dish
- alcohol wipes
- heavy, opaque paper
- tape and scissors
- sunlight

Note: Ward's Natural Science Establishment Inc. has a write-up for this laboratory and is a source of yeast culture.

Additional Resources

The Nelson textbook is the one that the ADLC materials wrap around. The Teacher's Resource is designed to help teachers make the most of the textbook. This support includes suggestions, possible journal entries, using the videodisc, initiating discussion, social issues, cooperative learning, evaluation ideas, and safety tips in the lab. Other helpful resources include the following:

Alberta Education. 1993. *Biology 30 Teacher Resource Manual.* Edmonton Alberta. Department of Education, Curriculum Branch.

Biggs et al. Biology: 1991. *The Dynamics of Life.* Columbus, Ohio: Merrill Publishing Co.

Galbraith, Don. 1993. *Biology Directions.* Toronto, Ontario: John Wiley and Sons.

Monger, G. et al. 1986. *Revised Nuffield Advanced Science – Biology*. Essex, England: Longman Group Limited.

Oram, Raymond. 1986. *Biology: Living Systems*. Columbus, Ohio: Merrill Publishing Co.

Philips, WD. et al. 1989. *A-Level Biology*. Toronto, Ontario: Oxford University Press.

Ritter, Bob et al. 1993. *Nelson Biology. Teacher's Resource*. Scarborough, Ontario: Nelson Canada.

Wallace, Robert A. et al. 1991. *Biology: The Science of Life*. Third Edition. New York, New York: Harper Collins Publishers Inc.

Media Resources

The following is a mandatory video for Module 5.

- *Protein Synthesis* ACCESS Network 324601-06 A Utilization Guide is available for this video from ACCESS Network.

Laser Videodisc – *The Living Textbook: Principles of Biology* can be ordered from Perceptix Inc. (1-800-267-7788). Bar codes and frame numbers are found in the *Nelson Biology Teacher's Resource* pages 206 to 207, 216, 225 to 226.

Note: Some of the suggested media may not be authorized by Alberta Education. Teachers should use their own discretion regarding the use of these resources in their classroom.

Section 1: Genes and Chromosomes

The concept of identifying genes and locating them on a chromosome is a difficult one for most people to comprehend. Prepare a bulletin board with pictures of DNA molecules showing their structures. Labelling the parts of DNA and chromosomes will also help students visualize the concepts presented in this section. Using a demonstration of building blocks will help the students understand the physical arrangement of chromosomes and the concept of crossing-over. Using pens with different coloured caps can also assist you in presenting a visual image of crossing-over. You may want to try snapping beads together to illustrate this concept as well as gene mapping. It is essential that students understand the difference between parental gene linkages and recombinant linkages produced as a result of crossing-over. Then a test cross will produce offspring that show these parental and recombinant phenotypes.

Section 1: Assignment Answer Key (40 marks)

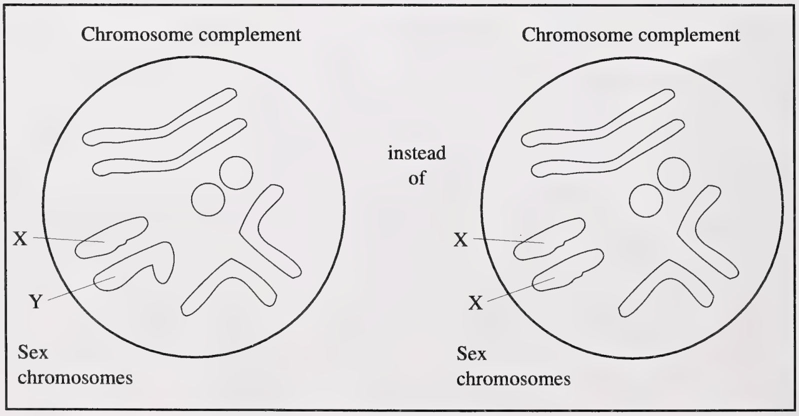
1.	D	3.	C	5.	A	7.	B	9.	C	11.	C
2.	B	4.	C	6.	B	8.	A	10.	A	12.	D

All multiple choice questions are 1 mark each.

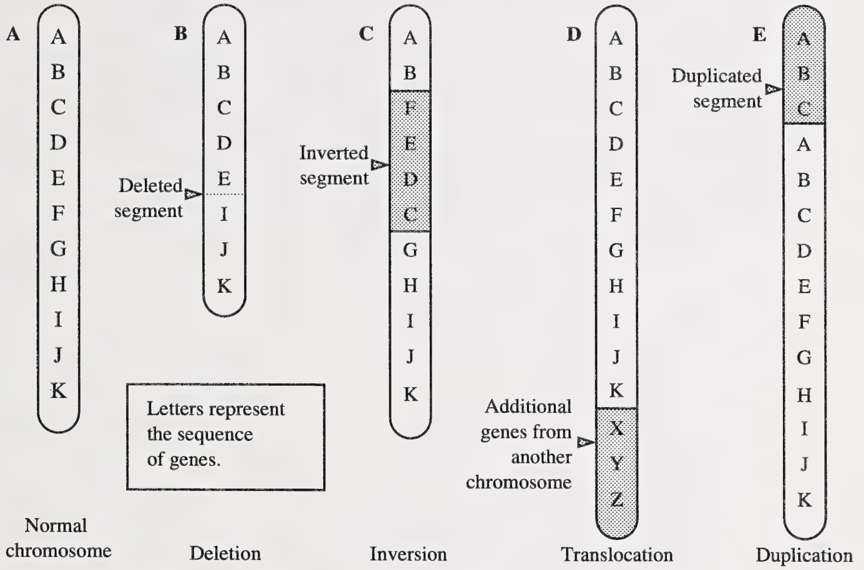
13. a. The student's response should be a discussion of the following:

First Law **(Diagram → 2 marks, Description → 1 mark)**

- The existence of sex chromosomes and the mechanism of gender determination results in some genes being carried singly instead of in pairs.



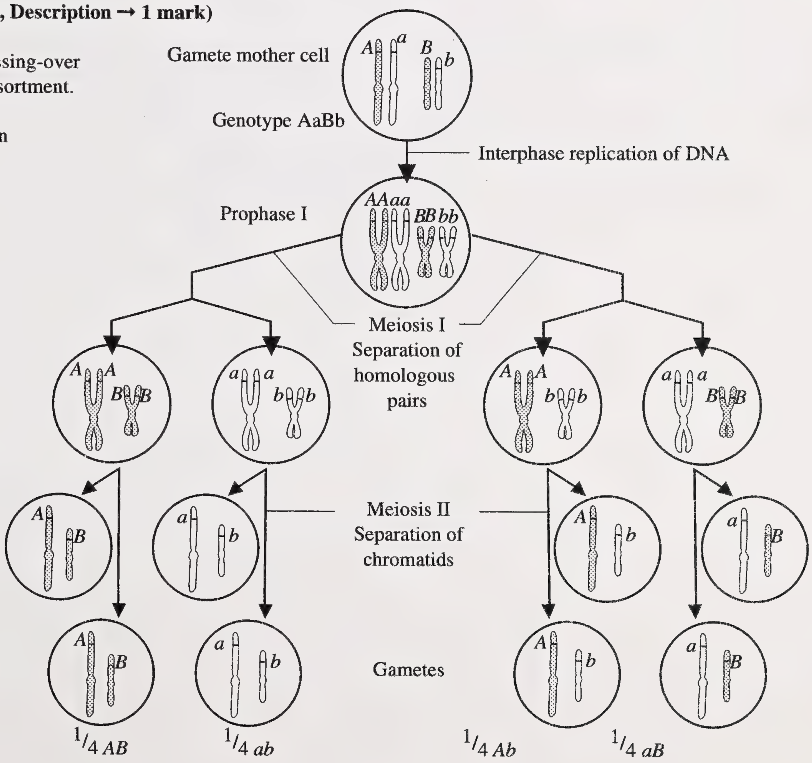
- Another possible answer could be that chromosome abnormalities that lead to inheritance of single genes as evidenced in deletions, inversions, translocations, or duplications also challenge the law of segregation.



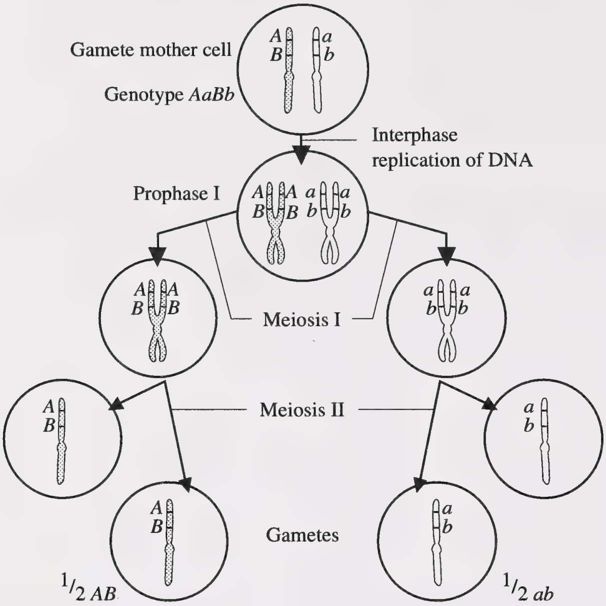
Second Law **(Diagram → 2 marks, Description → 1 mark)**

Knowledge of linked genes and crossing-over challenge the law of independent assortment.

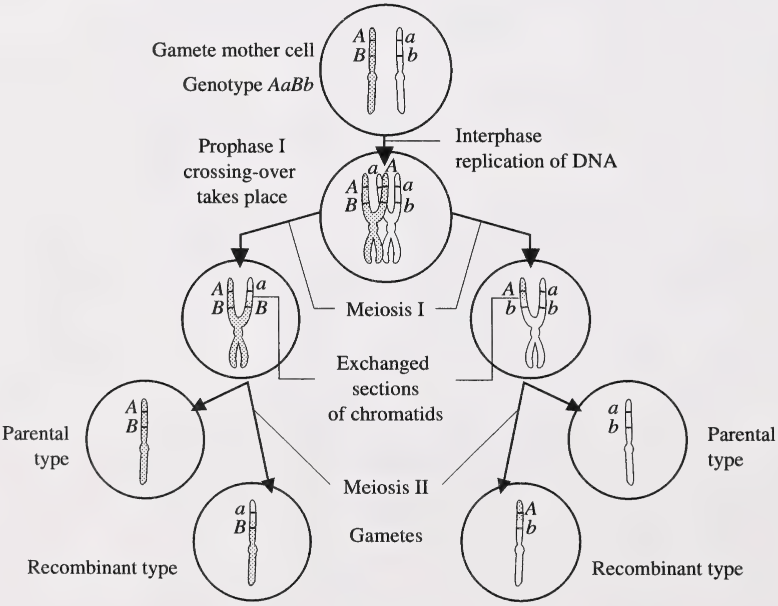
- Two pairs of alleles at loci on different chromosomes.



- Two pairs of alleles at different loci on the same chromosome pair where no crossing-over occurs.



- Two pairs of alleles at different loci on the same chromosome pair where crossing-over takes place.



b. Technology **(any 2 → 2 marks)**

- Light microscopes can be used to observe chromosomes.
- Electron microscopes also give direct observations.
- Test crosses in the lab allow for experimental evidence.
- X-ray diffraction allows for biochemical analyses.
- Gel electrophoresis can assist in identifying genes.
- Chromosome mapping helps to determine crossovers.

14. a. The F_2 generation will show four phenotypes in dihybrid cross ratio. **(1 mark)**

F_2:	9	:	3	:	3	:	1
	Smooth coloured		Smooth white		Wrinkled coloured		Wrinkled white

b. The number of F_2 progeny must be compared as percentages of a total of 7000. These can be compared to the 9:3:3:1 ratio also in percent form. **(2 marks)**

		:		:		:	
Predicted =	9 56.25%	:	3 18.75%	:	3 18.75%	:	1 6.25%
Actual =	73.21%		1.74%		1.79%		23.25%

c. Certainty of alleles can be determined and genotypes can be predicted with accuracy using a test cross. **(2 marks)**

d. The results as a percentage are

smooth, coloured seeds	2406	48.1%
wrinkled, coloured seeds	93	1.9%
smooth, white seeds	92	1.8%
wrinkled, white seeds	2409	48.2% **(1 mark)**

e. The genetic interpretation of the results is that the traits are linked and some recombination occurs. **(2 marks)**

f. If wrinkled, coloured and smooth, white represent recombinations at a frequency of about 2% each, then these genes must be about 4 map units apart on a chromosome (2 + 2 = 4) **(2 marks)**

15. a. Yes, because the ratio is not 1:1:1:1:1:1:1:1. **(1 mark)**

b.
$$\text{Linkage } (SC \rightarrow CV) = \text{Parent } \left.\begin{matrix} 417+0 \\ 430+0 \end{matrix}\right\rangle \frac{847}{982} = 86.3\%$$

$$\text{Recombinants } \left.\begin{matrix} 25+44 \\ 29+37 \end{matrix}\right\rangle \frac{135}{982} = 13.7\%$$

Map Distance = 13.7 **(1 mark)**

$$\text{Linkage } (cv \rightarrow ec) = \text{Parent } \left.\begin{matrix} 417+29 \\ 430+25 \end{matrix}\right\rangle \frac{901}{982} = 91.8\%$$

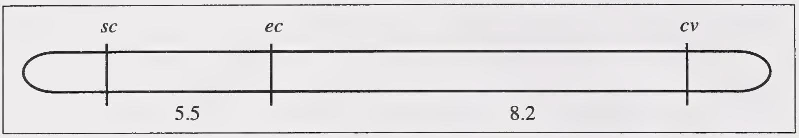
$$\text{Recombinants } \left.\begin{matrix} 44+0 \\ 37+0 \end{matrix}\right\rangle \frac{81}{982} = 8.2\%$$

Map Distance = 8.2 **(1 mark)**

$$\text{Linkage } (sc \longrightarrow ec) = \text{Parent } \left.\begin{matrix} 417+44 \\ 430+37 \end{matrix}\right\rangle \frac{928}{982} = 94.5\%$$

$$\text{Recombinants } \left.\begin{matrix} 25+0 \\ 39+0 \end{matrix}\right\rangle \frac{54}{982} = 5.5\%$$

Map Distance = 5.5 **(1 mark)**



(1 mark)

16. a. Eleanor carries the gene for hemophilia on one X chromosome and the gene for colour blindness on the other X chromosome. **(1 mark)**

b. The gene for colour blindness must have become linked to the gene for hemophilia by crossing-over. **(1 mark)**

c. Hemophilia → 1/2 (50%) chance because Eleanor is a carrier **(1 mark)**

Colour blindness → 1/2 (50%) chance because Eleanor is a carrier **(1 mark)**

Section 2: The Molecules of Heredity

The concepts in this section may be best understood as students compare the organization and application of spelling and grammar rules in the English language with the organization and application of biochemical rules in the nucleic acid and protein languages. The blueprint analogy seems to be a practical way for students to conceptualize how genetic information can act as a guide to allow cells and organisms to express their physical traits. Using models will allow the students to practise a hands-on approach to the central dogma of life. A discussion on whether a virus is living or nonliving is another way to present this concept. For life to exist, there must be DNA, RNA, and proteins. Cells possess all three, but viruses only have two. They require a host cell to provide the missing component. It is essential at the end of this section that students be able to describe protein synthesis from a DNA code, through mRNA and tRNA to a sequence of amino acids. They should be proficient in transcribing and translating.

Section 2: Assignment Answer Key (40 marks)

1. A
2. D
3. B
4. B
5. D
6. A
7. C
8. B
9. D
10. B
11. B
12. D

All multiple choice questions are 1 mark each.

13. The student's response should include a discussion of the following:

Concepts

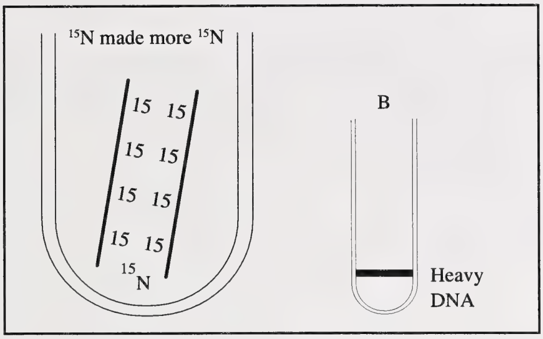
a.
- Culture C will show an intermediate band because one-half of the new double helix will be old ^{15}N and the other half will be new ^{14}N.
- Culture D will show an intermediate band and a light band because the second generation only has ^{14}N available.

After first replication DNA → ^{15}N ^{14}N → one medium band

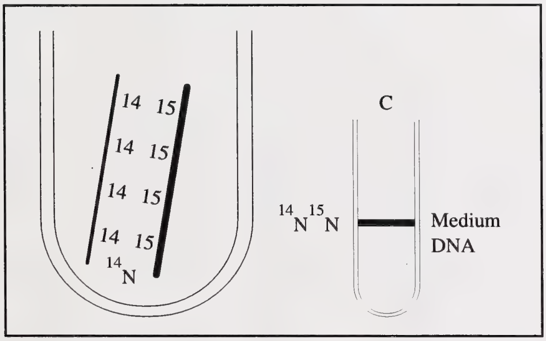
↙ ↘

After second replication DNA → ^{15}N ^{14}N and ^{14}N ^{14}N → two bands → one medium, one light

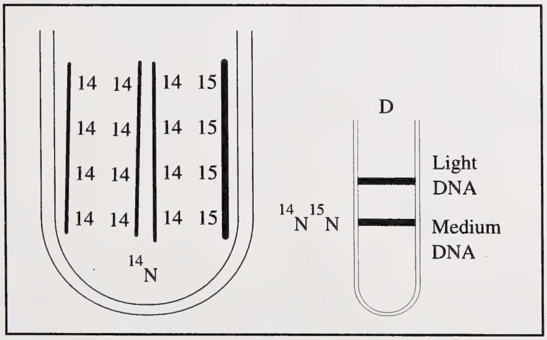
In a culture of ^{14}N normal replication occurred.



When these cells were placed in the ^{14}N medium, the next generation was half ^{14}N and half ^{15}N. The ^{14}N was incorporated. This produced a medium band of DNA in Culture C.



When a second generation occurred in the ^{14}N medium, the new DNA strands were partially old ^{14}N and old ^{15}N with all new ^{14}N. This produced a medium and a light band of DNA in Culture D.



(5 marks)

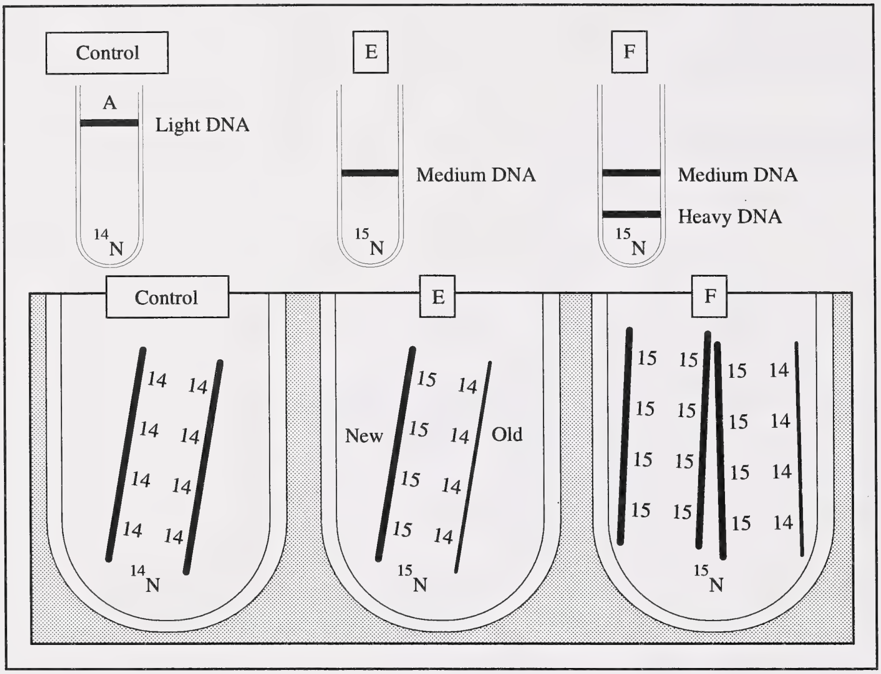
b. In the ^{15}N medium in cultures E and F the same mechanism will give the following results.

- Culture E will show an intermediate band because one-half of the new double helix will be old ^{14}N and the other half will be new ^{15}N.
- Culture F will show an intermediate band and a heavy band because the second generation only has ^{15}N available.

After first replication DNA → ^{14}N ^{15}N

↙ ↘

After second replication DNA → ^{14}N ^{15}N ^{15}N ^{15}N



(5 marks)

14. a. The Ames test is faster, less costly, and more accurate than other methods. **(1 mark)**

b. The Ames test involves testing the potential of a chemical to alter the DNA of an organism. **(1 mark)**

c. It is assumed that cells may become cancerous if their DNA is suddenly altered. A chemical that changes DNA then could lead to cancer. **(1 mark)**

d. If Chemical A alters the DNA in *Salmonella typhimurium* cells, then it has a potential to cause cancer. Ability to cause mutation equals potential to cause cancer. **(1 mark)**

e. The graph of Substance B indicates a harmless substance as no increase in growth occurs. Substance A causes an increase in growth. This indicates a change in bacterial DNA and so Substance A is potentially harmful. Substance C may be harmless initially but contact with liver enzymes kills the bacteria. This could indicate that the enzymes alter the chemical and make it toxic to living cells. **(1 mark)**

f. The mutant strain is unable to produce histidine. Histidine is necessary for growth. Without histidine no growth occurs. If a chemical causes a mutation to the bacterial DNA such that the bacteria can begin producing its own histidine, then growth will occur. **(1 mark)**

g. Bacterial growth indicates a change has occurred to DNA. Mutation of DNA is assumed to have been caused by the test chemical. The rate of growth is indicative of the amount of mutation and the potential of the chemical to alter DNA and cause cancer. Much growth equals much mutation which equals high carcinogenic potential. **(1 mark)**

h. The control component will be bacteria grown in a medium without histidine. No growth is expected in the control. **(1 mark)**

i. The response variable is bacterial growth. **(1 mark)**

j. Liver enzymes may break down harmless chemicals into toxic components. This may indicate what could happen to a harmless chemical that enters the body. **(1 mark)**

15. The error or mutation is a stop codon ATT at the seventh amino acid (proline). **(2 marks)**

This should be corrected to GGT, GGG, GGA, or GGC to code for proline. **(2 marks)**

Mutant DNA

TAC AAT CGA CGG ACA CCT GAT ATT AAT CAA TTT ATT
initiator mutant stop codon terminator

Corrected DNA

TAC AAT CGA CGG ACA CCT GAT GGT AAT CAA TTT ATT
initiator alanine cysteine leucine leucine lysine
leucine alanine glycine proline valine terminator
(4 marks)

Note: GGT, GGG, GGA, and GGC are equally acceptible.

Section 3: Biochemical Technology

A great way to introduce the concept of abnormalities in genetic codes is to gather together the bar codes from various product wrappers. Each bar code can represent a gene and you can create a chromosome by linking some together. Exchanging bar codes, cutting them into smaller pieces, or rearranging them illustrates exactly what happens when genetic mutations occur. You may wish to invite a geneticist or biochemical engineer to speak to the students about the current research and applications that are being used in the world. Perhaps your class will include a student whose family has first-hand experience in dealing with some of the more common examples of mutations like Down syndrome, skin disorders, or diseases. A presentation would make these conditions more meaningful and understandable. A field trip to an agricultural site where genetic engineering is used to improve the quality and quantity of food production would also be valuable. Students should be able to identify changes in a DNA code and the effect on protein synthesis as an extension of protein synthesis.

Section 3: Assignment Answer Key (20 marks)

1. A 2. B 3. A 4. A 5. A

All multiple choice questions are 1 mark each.

6. The student's response should include a discussion of the following:

a. Concepts **(Any 3 → 3 marks)**

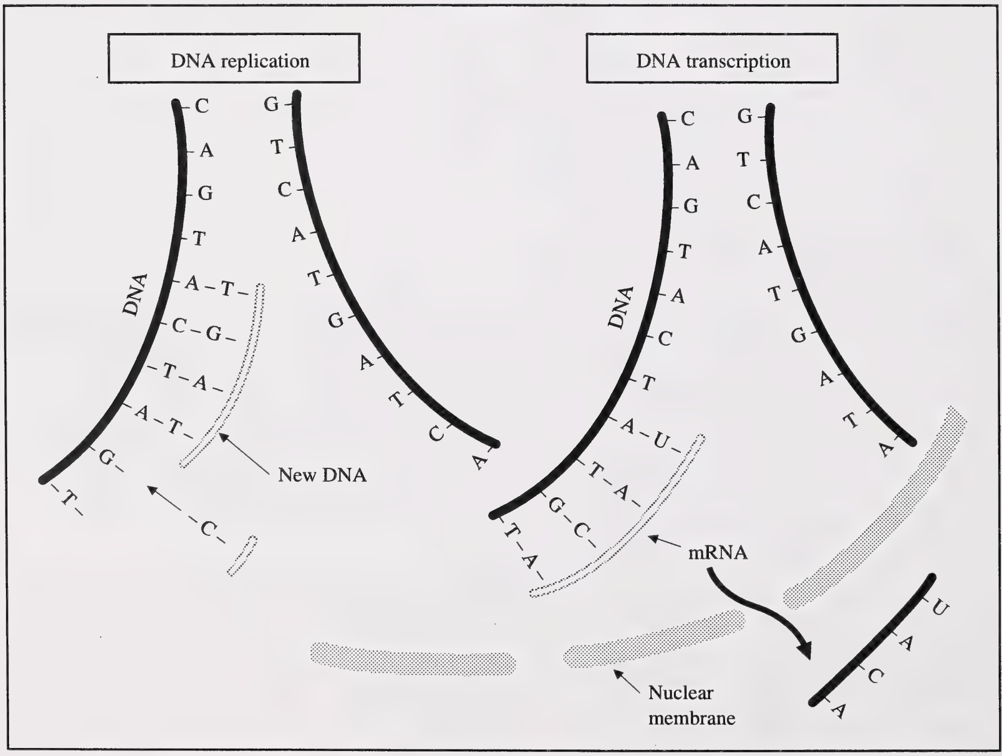
- Point mutations that alter a single gene may result from base pair substitution.
- Point mutations may also result from base pair deletion.

- Point mutations may result from base pair addition.
- Chromosomal mutations may occur during crossing-over where segments of genes are added to one chromosome only and lost from the other.
- Nondisjuction of chromosome pairs will create an abnormal karyotype.
- Mutations are caused by mutagens such as viruses, radiation, chemicals, and faulty ligases.

b. Technology **(Any 2 → 2 marks)**

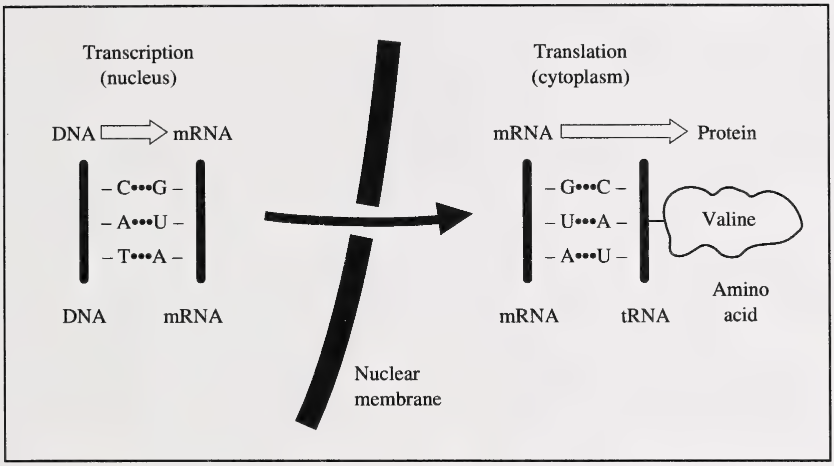
- Cloning is one form of genetic engineering.
- Recombinant DNA utilizes bacteria.
- Gene therapy allows a healthy gene to replace a defective one.
- Hybridization is used in agriculture.
- Chemotherapy
- Radiation

7. a. In DNA replication a single strand of DNA nucleotides acts as a template for the formation of a complementary strand. The complementary strand attaches, forming more DNA. This precedes mitosis. In DNA transcription the DNA code is transferred to mRNA. The mRNA leaves the nucleus for translation in the cytoplasm. Both processes produce a complementary nucleotide sequence. In replication the complementary DNA strand will contain thymine. In transcription the complementary strand of mRNA will contain uracil instead of thymine. There is no thymine in mRNA.



(4 marks: 2 for explanation, 2 for diagram)

b. Transcription is the process in which the DNA code is transferred to mRNA. The mRNA molecule then leaves the nucleus. In translation tRNA molecules deliver amino acids to the ribosome. The amino acids are linked to form proteins according to the DNA sequence encoded in mRNA.



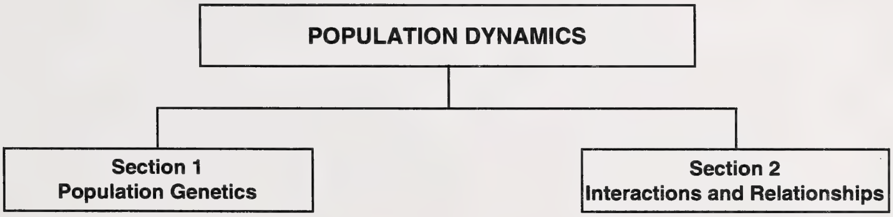
(4 marks: 2 for explanation, 2 for diagram)

c. Initiator and terminator genes are transcribed but not translated. They start and stop protein synthesis but are not part of the proteins themselves. **(2 marks)**

Module 6: Population Genetics and Interactions

Overview

This module brings to a conclusion the students' study of genetics. The Mendelian genetics that were studied in Module 5 were used as a springboard to discuss how natural selection results in speciation. Some math skills are necessary for the analysis of gene frequencies in the study of population genetics. With this knowledge students can then use the Hardy-Weinberg principle to analyse whether or not populations are evolving. How populations react with other populations brings the module to a conclusion. The emphasis here is the predator-prey relationship and competition. The stage is now set for students to move onto the final module and complete the course.



Evaluation

The evaluation of this module will be based on two assignments:

Section 1 Assignment	**55 marks**
Section 2 Assignment	**45 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction of Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of supplies and equipment necessary to complete the investigations and activities in Module 6. Some investigations are optional. Learning facilitators are advised to examine the investigations prior to acquiring materials.

Section 2: Activity 3

- magnifying glass
- sterile filter paper
- wax pencil
- 1 L of cooled, boiled water
- nine petri dishes
- tweezers
- exudates A and B
- 250 mL methanol from pharmacy
- 3 10-mL graduated cylinder
- 100 seeds each of canola, alfalfa, cucumber (or radish)

Note: This investigation is designed by Prairie Biological Inc. in Edmonton. They may be contacted for materials at the following address. Their own lab procedure differs slightly. Radish seeds are recommended over cucumber seeds for shorter germination time and lower cost.

Prairie Biological Inc.
4290-91 A Street
Edmonton, Alberta
Phone: 450-3957

Section 2: Extra Help

- microslide viewer
- microslide set #218, Mechanisms for Survival

Resources

Module 6 wraps around the *Nelson Biology* textbook. A teacher's resource guide is also available from Nelson Canada. This resource guide has answers to questions in the text as well as bar codes and frame references to support materials on the *Living Textbook* laser videodisc. The *Living Textbook* laser videodisc is available from the following address:

Optical Data Corporation
30 Technology Drive
Warren, N.J. 07059
USA
Phone: 1-800-267-7788

Additional Resources

Campbell, N.A. 1992. *Biology*, 3rd. ed. Don Mills, Ontario: Benjamin/Cummings Publishing Co. Inc.

Galbraith, Don. 1993. *Biology Directions*, 1st. ed. Toronto, Ontario: John Wiley and Sons Canada Limited.

Mader, S. 1990. *Biology*, 3rd. ed. Dubuque, Iowa: Wm. C. Brown Publishers.

Media Resources

The following are mandatory videos for Module 6:

- Organic Evolution Series: *Factoring in Mendel* ACCESS #VC289501-6
- Organic Evolution Series: *The Population Picture* ACCESS #VC289501-06
- Science Alive: *The Spruce and the Hare* ACCESS #VC315508

The following are optional videos for Module 6:

- From the series Trials of Life – *Hunting and Escaping, Friends and Rivals, Living Together* (Time-Life Video)
- *Lions and Hyenas – Eternal Enemies* (National Geographic)

Section 1: Population Genetics

Population genetics has students apply knowledge from the Mendelian level to speciation. The concept of what a species is must be firmly established before the students take on the task of evaluating differences in gene pools using the Hardy-Weinberg calculation. It is important to note that the students should not only be able to perform the calculation but understand its basis in order to fully grasp the concept. The Organic Evolution Series video is a must for this module and it can be used as an introduction rather than Extra Help.

Section 1: Assignment Answer Key (55 marks)

1. D	3. B	5. A	7. B	9. D	11. C	13. D	15. D	17. D
2. C	4. D	6. D	8. C	10. C	12. C	14. A	16. A	18. B

All multiple choice questions are 1 mark each.

19. Let *F* be the dominant gene for freckles and let *f* be the recessive gene. Then *ff* will result in a lack of freckles. If the frequency of *ff* is 2%, the percentage of heterozygous genotypes is as follows. **(2 marks)**

$$p^2 = 2pq + q^2 = 1$$

$$q^2 = ff = 2\% \text{ or } 0.02$$

$$q = \sqrt{0.02} = 0.14$$

$$\begin{aligned} p &= 1 - q \\ &= 1 - 0.14 \\ &= 0.86 \end{aligned}$$

$$\begin{aligned} Ff &= \text{heterozygous} \\ &= 2pq \\ &= 2(0.86)\,(0.14) \\ &= 0.24 \\ &= 24\% \end{aligned}$$

20. **Note**: Reproductive isolation refers to physical, physiological, or behavioural barriers that prevent successful mating. The answer is a – d – c – b. **(2 marks)** Give 1 mark if student answers a – d – b – c.

21. The Hardy-Weinberg principle is difficult to observe in nature for a variety of reasons.

    - Populations that occur in nature are not always large in size due to fragmentation.
    - For some populations mating is not random.
    - Mutations are constantly occurring in any population due to many sources of genetic error.
    - Gene flow from geographically and reproductively separated members of the same species occasionally occurs.
    - The Hardy-Weinberg principle is observable in a laboratory setting, but in nature it will not be seen because populations are continually evolving and are not all equally viable. **(5 marks)**

22. a. i. 64% are able to taste PTC; therefore, 36% must not be able to taste PTC. This is the homozygous recessive group. **(1 mark)**

    ii. $q^2 = 0.36$; therefore, $q = 0.6$, $p = 1 - q$. $1 - 0.6 = 0.4$. Heterozygous is $2pq$ or $2(0.6 \times 0.4) = 0.48$. The percentage of heterozygotes is 48%. **(3 marks)**

    iii. If $q^2 = 0.36$ and $2pq = 0.48$, then all members that carry the recessive gene are $0.48 + 0.36 = 0.84$ or 84%, or if $p = 0.4$ then $p^2 = 0.16$ and all of the other members will carry the recessive allele. $1 - 0.16 = 0.84$ or 84%. **(2 marks)**

    b. If the next generation maintains the same percentages, then the population must be in Hardy-Weinberg equilibrium – it is not evolving and none of the Hardy-Weinberg conditions are being violated. **(2 marks)**

23. a. $EE \text{ in } 1964 = \frac{380}{472} = 0.81$, so frequency of E allele (q) is $\sqrt{0.81} = 0.9$ or 90%.

$EE \text{ in } 1969 = \frac{1174}{1352} = 0.87$, so frequency is $\sqrt{0.87} = 0.93$ or 93%.

$EE \text{ in } 1972 = \frac{1478}{1623} = 0.91$, so frequency is $\sqrt{0.91} = 0.95$ or 95%.

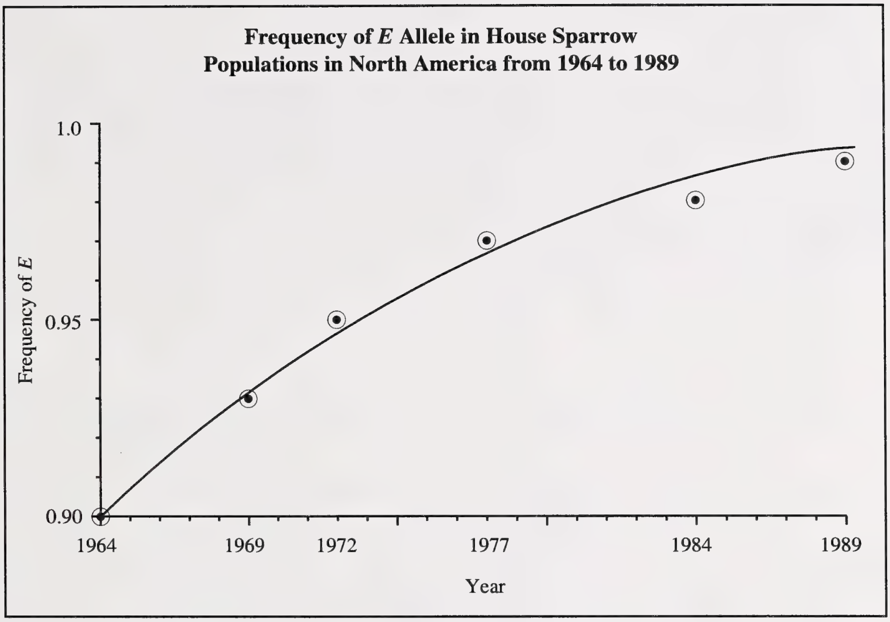
$EE \text{ in } 1977 = \frac{1394}{1467} = 0.95$, so frequency is $\sqrt{0.95} = 0.97$ or 97%.

$EE \text{ in } 1984 = \frac{1086}{1137} = 0.96$, so frequency is $\sqrt{0.96} = 0.98$ or 98%.

$EE \text{ in } 1989 = \frac{932}{955} = 0.98$, so frequency is $\sqrt{0.98} = 0.99$ or 99%.

(3 marks)

b.



Frequency of *E* Allele in House Sparrow Populations in North America from 1964 to 1989

(4 marks)

c. The frequency of the *E* allele has been increasing since 1964 from a low of 0.90 to a high in 1989 of 0.99. This population of *Passer domesticus* is evolving, probably due to some stress on the population. Eventually the *D* allele will disappear if the selection pressure is maintained. The entire population will contain only the *E* allele. **(2 marks)**

24. a. DDT acts as a selective pressure on the population of insects. Those insects that cannot tolerate the pesticide will die out. Directional selection would begin to occur and the insects that have a variation that withstands the DDT will survive and proliferate. If this pressure continues, a new species could develop. **(3 marks)**

b. Penicillin is a drug used to prevent the growth of bacteria. A patient has a prescription for penicillin as a result of a streptococcal infection. The entire prescription is not taken because the patient begins to feel better. A number of the bacteria will still be present in the patient's system and will survive. A large portion of those that survive will be resistant to the drug due to natural variations. This strain of bacteria will then proliferate and cause the patient to feel ill or infect others. The penicillin will now have a lesser effect on the entire population of bacteria. Natural selection is occurring because a particular trait is being selected for resistance to penicillin. **(4 marks)**

c. The natural selection of a species could be reduced if selective pressure was placed upon the undesirable species that would force them to evolve. In a garden, an insect feeds upon the leaves of potato plants. If another insect were placed in the garden that ate any of the undesirable insects found on the potato plants, then this would be a selective pressure. The potato-eating insect would have to evolve to eating a different food source or be killed by the other insect. **(2 marks)**

25. What Aldo Leopold is stating is that human activities often disrupt habitat to such a point that certain organisms become extinct. Once these organisms are lost, they cannot be brought back. An ecosystem operates as a whole unit with each organism taking on a vital role. Losing parts of the ecosystem will result in a reduction of the ecosystem's ability to withstand change. Eventually a point will be reached where keystone species can no longer maintain the ecosystem and it will be destroyed. Maintaining biodiversity results from maintaining viable ecosystems. **(2 marks)**

Section 2: Interactions and Relationships

The major theme in this section deals with the connection of all living things. This builds on the ideas covered in Biology 20. An analysis of predator-prey relationships is introduced in Activity 1 and analysed in more depth in Activity 2. Activity 3 introduces and leads the students through the other forms of symbiotic relationships. There is a major investigation in the Enrichment in which the students discover how plants use chemical means to compete with neighbouring individuals. This investigation can be extended by having the students collect various other plants, prepare their own exudates (serial dilutions can be used), and then observe the results. Contact Prairie Biological Inc. in Edmonton for materials.

Section 2: Assignment Answer Key (45 marks)

1. D	3. C	5. A	7. A	9. C	11. B	13. C	15. D	17. C	19. B
2. D	4. D	6. C	8. A	10. C	12. D	14. B	16. B	18. C	20. D

All multiple choice questions are 1 mark each.

21. a. How does the hare population (manipulated variable) affect the population of great horned owls (responding variable)? **(1 mark)**

b.

Year	# of Owls Nesting		Relative Hare #	Percentage of Hare in Diet of Owls
1966	10	20%	*n*	23%
1969	18	100%	7*n*	50%

(2 marks)

c. The survey will have to be conducted at the same time of the year. This would then take into account the temporary nature of nesting behaviour. The sampling technique for determining what the owls have been feeding upon would also have to be the same in order to produce reliable results. Another fixed variable would be to examine the same sites through the years. There should be no change in habitat as that would affect how the hares reproduce and how the owls hunt. **(2 marks)**

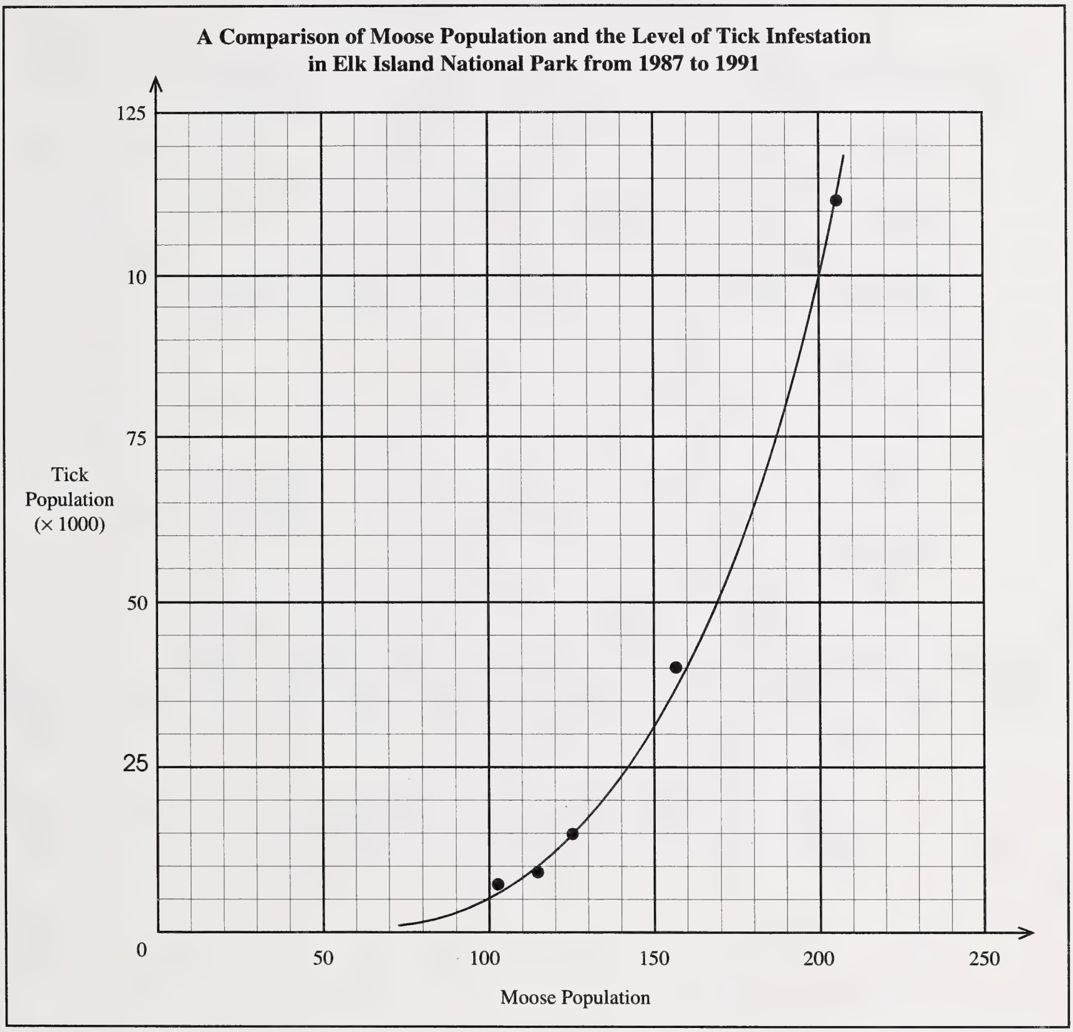
d. From the data it can be concluded that there is a direct correlation between the number of hares and the number of owls. This can be attributed to increased health of the adult birds which then stimulates more effective breeding behaviour. A stronger, healthier female will produce more eggs and these young will also have a greater chance of survival due to increased food. The increase in the percentage of hares in the owl diet clearly indicates that the owls are optimizing this resource and as a result show an increase in their population.

Note: Students may only state that the hare population positively affects the owl population beginning with an increase in nesting birds. **(3 marks)**

22. a. The tiger moths emit these sound waves in order to interfere with the sonar locating system of the bats. The bats locate moths by examining the differences in the reflection of the sound waves. If the sounds made by the moth are of the same frequency, then the difference in reflection times is distorted and the moth may avoid predation. To a degree, the moth may imitate the bat's cries. **(2 marks)**

b. The moth population, in order to increase its chance of survival, favours those individuals that emit these sounds. Those individuals that do not are more likely to be eaten and have their genes removed from the gene pool. The bat, on the other hand, will have to change its predation behaviour, for example, flying pattern, in order to keep utilizing the tiger moth as a food source. Those individuals who make these changes due to genetic alteration of behaviour will be better hunters and as a result will be selected for. **(4 marks)**

23. a.



A Comparison of Moose Population and the Level of Tick Infestation in Elk Island National Park from 1987 to 1991

(3 marks)

b. The numbers of ticks that infest a moose are directly proportional to the moose population. As the moose population increases, so do the numbers of ticks that infest a moose. Over the five-year study period the populations varied in unison. The increase in ticks is probably due to the increased contact between individual moose. **(2 marks)**

24. A predator kills its prey. Once that organism is consumed, there is no more energy or matter to be had. A parasite slowly withdraws small amounts of matter and energy from the host resulting in the slow, eventual death of the host or a continued relationship at the host's expense. Economically, capital refers to the initial investment while the interest is what was earned on that investment. **(2 marks)**

25. The red-black vole feeds upon the fruiting body of the fungi. The vole travels from place to place. The spores of the fungi concentrate in the feces, and when expelled near a tree produce a new fungus. The vole-fungus relationship is therefore one of mutualism. The relationship between the tree and vole is mutualistic because without the tree, the fungus would not grow and the vole would then lose a valuable food source. Without the vole, the trace would not receive the fungal spores. **(3 marks)**

26. The order of the symbols is not significant. **(2 marks)**

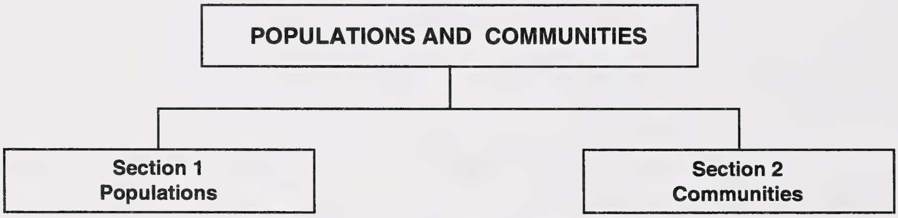
Organism A/B	Relationship
+/0	commensalism
+/–	predation
+/+	mutualism
+/–	parasitism

Note: Award 2 marks if all correct, only 1 mark if one wrong; no marks if two or more are wrong.

Module 7: Populations and Communities

Overview

The focus of this module is on the ways populations change over time and the expression of these changes in quantitative terms. The module begins with descriptions of populations as stand-alone and as populations within other populations. Indirectly this is also an introduction to communities. Density and rate of change are studied to enforce the concept of dynamic equilibrium. Dynamic equilibrium is almost a contradiction of terms but makes sense in the long-term. Students learn about S-curves and J-curves and *r* and *K* selected population change. Implications for the human population are included. Section 2 introduces students to succession. The concept is not explored to extensive depth but is consistent with the Program of Studies and textbook. Succession is presented as a consequence or response by populations and communities to environmental conditions. Present succession as something directed and controlled by biotic (populations, communities) and abiotic (environment) factors. In this way the role of fire, logging, and other human activities may be appreciated. Chaos theory is presented in this section. Be careful not to confuse students as this is only a developing theory. A brief presentation of chaos theory in layman's terms can be found in the novel *Jurassic Park*. Section 2 concludes with an extensive activity intended to prepare students for the Final Test and Diploma Examination.



If the modules of this course are done in order this module will be the last of the student's High School Biology career. It is important in preparation for Diploma exams that the student be familiar with the themes presented throughout the course and be able to apply their knowledge to various STS issues. By applying their knowledge a student should feel confident in analysing experimental data in both a written response and graphic representation.

Evaluation

The evaluation of this module will be based on two assignments:

Section 1 Assignment	**60 marks**
Section 2 Assignment	**40 marks**
TOTAL	**100 marks**

Evaluation Suggestion

In each set of assignment answers there may be one or more answers where the teacher will grade written communication skills. This is clearly indicated in the total possible marks for the question. Use the following guideline for evaluating students' written responses.

Communication (2 marks)

Score	Scoring Descriptions
(2) Excellent	The response communicates the concepts clearly and logically, demonstrating internal consistency of thought. Linkages between cause-and-effect relationships are shown and clearly expressed. Complete sentences that make effective use of scientific vocabulary are used. If applicable, suitable diagrams/ sketches are used to illustrate the verbal descriptions. The response addresses the major points of the question.
(1) Satisfactory	The response may require more than one reading to abstract the sense. Linkages between cause-and-effect relationships are shown. Some internal inconsistency of thought is evident. Some scientific vocabulary is used. The response addresses some of the major points of the question.
(0) Unacceptable	The response shows little evidence of internal consistency of thought. The communication is muddled because of inappropriate vocabulary and incomplete sentence structure. The length of the response is inadequate to address even one of the major points of the question.

Science Skills Assessment

This module contains a methodology for the assessment of science skills. Assessment is performed by both the student and a teacher-marker. An explanation of skill assessment is given in the introduction to Module 1. A more complete explanation may be found in *A Model for the Assessment and Evaluation of Scientific Problem-Solving Skills* from Student Evaluation Branch, Alberta Education. A further reference, *Performance Assessment Banks, Activities, and Instruments* produced by the Instructional Technology and Media Unit of the Alberta Distance Learning Centre is recommended.

Materials and Equipment

The following is a list of materials and equipment necessary for an individual to complete the investigations and activities in Module 7. Adjust the amount of equipment if more than one individual is involved.

Section 1: Activity 2

- 60 Brine shrimp eggs
- 5% saline solution
- powdered dried yeast
- two 50 mL test tubes
- magnifying lens

Section 2: Activity 2

- Lodgepole pine cones (closed)
- access to a heat source (stove)
- large forceps or tongs
- timer
- metal tray

Section 2: Activity 3

- light meter
- tape
- trowel
- tacks
- soup can
- string
- psychrometer
- compass
- anemometer
- plastic bags
- clinometer
- marking pens
- centigram balance
- water container
- air and soil thermometers
- ping pong ball

Resources

This module wraps around the Nelson Biology textbook.

Additional Resources

Ritter, R. and Samiroden, W. 1993. *Teacher's Resource to Nelson Biology*. Scarborough Ontario: Nelson Canada.

The teacher book provides information on how to initiate a new chapter of study, address alternative concepts, make connections between themes, provides ideas for possible journal entries, videodisc references, ideas for initiating a discussion, and the answers to all text questions.

Nelson has also published a classroom resource binder that contains a weekly planner, additional laboratory activities, additional readings, blackline masters, crosswords, and concept maps.

Media Resources

- Aspects of Ecology – *Populations* ACCESS # VC241803*
- Science Alive: *The Spruce and the Hare* – ACCESS #315508*

Section 1: Populations

Populations are studied by first describing the ways in which growth and decline occur. The basic terms required for an understanding of the material are also presented. The various growth curves and population strategies that take place are tied together. Students must be encouraged to link concepts covered in Module 6 while completing this section. An analysis of human population growth is included in Activity 3. Students should be challenged to develop attitudes towards the difficult issues presented in the activity.

Section 1: Assignment Answer Key (60 marks)

1. A
2. C
3. C
4. B
5. C
6. B
7. D
8. D
9. C
10. B
11. D
12. A
13. B
14. C
15. C
16. D
17. A
18. C
19. B

All multiple choice questions are 1 mark each.

20. b – d – a – c **(1 mark)**

21. a. The curve which represents the algae is A. **(1 mark)**

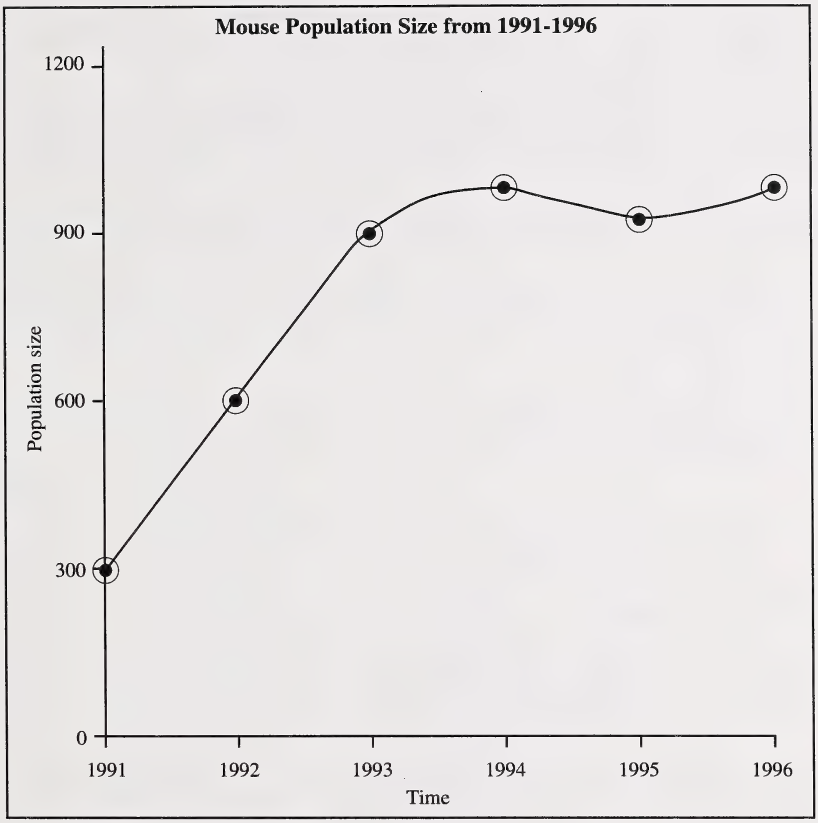
b. The density of algae will decrease due to the increase in the consumer *Daphnia* and its requirement for food. The algae would not be able to reproduce fast enough to keep the population size at the previous level. **(2 marks)**

c. By the following week the density of *Daphnia* will fall because the algae population fell. Food scarcity, as a density-dependent factor, will lower the number of *Daphnia* that can be supported. **(2 marks)**

d. If another species were added to the tank it would act as a competitor of the *Daphnia*. The interspecific competition would cause both consumer populations to initially decline. One species might be able to out-compete the other, driving it into extinction. The algae population would also fall due to the increase in consumers. **(3 marks)**

22. a. The population of mice would be K-selected because the population is density dependent. When the density of mice began to increase, the fecundity fell indicating that the population could not support any more members. **(3 marks)**

b. Three limiting factors that would affect the density of the population are food supply, availability of living space, and disease which would spread because of the high density. **(3 marks)** c.



Mouse Population Size from 1991-1996

(4 marks)

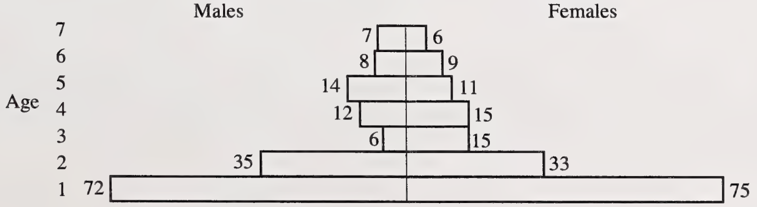
23. Biotic potential is the maximum number of offspring that can be produced by a species. If a population was always reproducing at the biotic potential, the population of all species would be much greater than actual levels. Populations need a check to keep population size down. This check is environmental resistance. There are many factors that contribute to environmental resistance. Food availability, space, climate, and the presence of predators are but a few of the factors that limit a population.

    Actual population size is determined for every species by determining what the biotic potential is and reducing that number as a result of environmental resistance factors. Small fluctuations in population size are expected due to the changing interaction of limiting factors and biotic potential. **(4 marks for interpretation; 2 marks for communication)**

24. The occurrence of mange is a density-dependent factor of environmental resistance in controlling the population of coyotes. When the density of coyotes becomes high enough that there is a greater deal of contact between individuals in the population, mange will begin to spread. When winter sets in, those members of the population with severe hair loss will die of hypothermia. The death of these animals will reduce the density of coyotes, thereby reducing the opportunity for mange to spread. **(3 marks)**

25. a.

Population Pyramid for White-tailed Deer



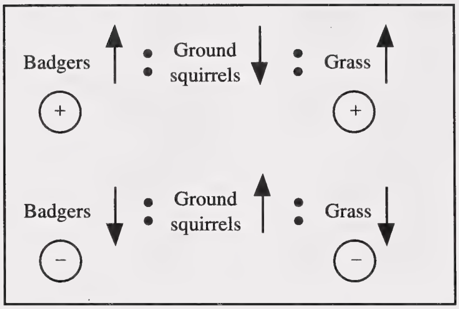
(3 marks)

b. The pyramid shows the age and gender structure of a population of white-tailed deer. The pyramid has the general pattern of a growing population because of the wide base of young. If survival rates are maintained, the population will grow because the number of deer surviving to reproductive age is high. **(3 marks)**

c. The animals at age 3 could have died due to a number of disasters: a flash flood, a forest fire, or high incidence of hunting of that age group. As a result of this, the number of new fawns will probably decrease because there are fewer deer at the age 3. **(2 marks)**

26. a. An increase in ground squirrels will have a positive affect on the badger population by providing more food. At the same time, an increase in ground squirrels will have a negative affect on the amount of grass as more grass will be eaten. **(2 marks)**

b. The badger population and grass population are related through the ground squirrel population. An increase in badgers will reduce the ground squirrels. Less grass will be eaten and the grass will increase. Conversely a decrease in badgers will allow ground squirrels to increase. The ground squirrels will consume more grass and the grass will decrease. **(2 marks)**


Badgers ↑ : Ground squirrels ↓ : Grass ↑
+
+
Badgers ↓ : Ground squirrels ↑ : Grass ↓
−
−

(1 mark)

Section 2: Succession

Succession is studied by first learning the basic vocabulary and then proceeding through case studies and activities to gain a better understanding of the concept. If you have access to the videos listed on succession, they are useful for viewing succession after a fire and over many years.

Section 2: Assignment Answer Key (40 marks)

1. B
2. C
3. B
4. A
5. D
6. A
7. D
8. C
9. B
10. B
11. D
12. B
13. D
14. D
15. A

All multiple choice questions are 1 mark each.

16. a. Problem: How do conditions of the buds on aspen trees affect the number of shoots produced?

- Manipulated variable = conditions of buds
- Responding variable = number of shoots produced **(1 mark)**

b. If the number of buds on the tree are reduced or damaged, then the tree will perceive that the adult is at risk of dying or being severely damaged. As a result, it will increase the number of shoots produced in order to maintain its dominance of the plant community. **(2 marks)**

c. This information supports the hypothesis of bud damage inducing the production of shoots. When the caterpillars eat the leaves, the same effect results. Something that the leaves produce inhibits the formation of shoots. Damage to the aspen trees is causing a reaction similar to the removal of the buds. As these trees are downwind, it would suggest a chemical signal is involved. **(2 marks)**

17. a. The samples at the bottom represent the earliest data. As time passes, layer upon layer of dust including the pollen is deposited at the site. The most recent material will be at the top. **(1 mark)**

    b. The oldest data suggests that the region was covered mainly by spruce and fir with just a few pines present. As time passes, spruce become more dominant. Then there is a change to pine being the dominant vegetation with some deciduous tree establishing populations. Eventually the pines disappear and are replaced by grasses and deciduous trees. A fire may have occurred destroying the pine forest. **(3 marks)**

    c. Over the last 11 000 years, the climate must have changed to favour the climax communities indicated. From the data, it appears that the climate became warmer and drier than it once was. **(2 marks)**

    d. The pollen layer at 0.6 m indicates an increase in the pine population. This could be accounted for by a cooling down of the climate causing better growth conditions for the pine trees and a reduction in the grasses and deciduous trees. The 0.6 m layer also contains ashes indicating a forest fire. **(2 marks)**

18. a. During the fire the pines would be killed. Heat from the fire would cause their cones to open and release seeds a few days after the fire. Shortly after the fire, the region would be dominated by grasses and other herbs. Deciduous aspens would send out shoots and appear. Soon after, the pine seeds will germinate. Most of the burned area will be covered with a thick growth of pines within 10 years. Eventually the region will again support a mature pine forest. **(2 marks)**

    b. The cooler, moist climate will be able to support spruce trees rather than pines which grow in a drier climate. The period of time would allow significant growth of spruce from within the microenvironment within the region. After the 100-year period there will probably be a significantly larger number of spruce trees in the forest. **(2 marks)**

19. a. The student was trying to establish the effect of microclimate on the development of dandelion leaves. **(1 mark)**

    b. There are many controlled or fixed variables to choose from. A list includes soil, watering, pot size, and size of original dandelions. Accept other possible answers. These variables must be kept constant in order to produce reliable results. If these are not maintained, then any variation in your observations cannot be attributed to the manipulated variable, microclimate. **(3 marks)**

    c. The dandelions that grow on the north side of the house have larger leaves regardless of their origin. This indicates that it is the microclimate in this region that produces the visible differences in the leaves. The abiotic factors on the north side of the house would include lower light intensity due to shading and a higher moisture content due to reduced evaporation. The reduced evaporation is a result of a combination of factors. These would be cooler temperatures, lower light levels, and higher relative humidity. All of these work together to reduce the evaporation. The leaves may also be bigger in order to capture enough sunlight to carry on sufficient photosynthesis to meet the plant's needs. As the light is reduced, the surface area of the leaf has to be increased in order to capture enough energy to carry out the photosynthetic reactions. **(3 marks)**

    d. Dandelions can regrow from small pieces of root. This is a form of asexual reproduction. If all of the experimental plants were grown from one individual, then they would be clones with the same genetic information. These plants could then be tested in different locations. Also accept answers that use tissue culture to produce the clones. **(1 mark)**

CHARTING GROWTH IN SCIENCE SKILLS

Feedback From Assignments			Initiating and Planning		Collecting and Recording		Organizing and Communicating		Analysing		Synthesizing and Integrating		Evaluating	
Module	Section	Question	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher
1	1	12												
	2	12												
		14												
	3	12												
2	1	27												
	2	18												
3	1	13												
	2	13												
	3	6												
4	1	15												
	2	10												
	3	15												
5	1	14												
		15												
		16												
	2	13												
		15												
	3	7												
6	2	21												
7	1	2												

Final Test

Included here is the answer key to the final test and the student's copy of the final test which is designed for photocopying and possible faxing.

Note:

The answer key and student's copy of this final test should be kept secure by the teacher. Students should not have access to this test until it is assigned in a supervised situation. The answers should be stored securely and retained by the teacher at all times.

BIOLOGY 30 FINAL TEST ANSWER KEY

PART A – MULTIPLE CHOICE

1 Ⓐ Ⓑ Ⓒ ●
2 ● Ⓑ Ⓒ Ⓓ
3 Ⓐ Ⓑ ● Ⓓ
4 Ⓐ ● Ⓒ Ⓓ
5 ● Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ ●
7 Ⓐ Ⓑ ● Ⓓ
8 Ⓐ Ⓑ ● Ⓓ
9 Ⓐ ● Ⓒ Ⓓ
10 ● Ⓑ Ⓒ Ⓓ
11 Ⓐ Ⓑ ● Ⓓ
12 ● Ⓑ Ⓒ Ⓓ
13 Ⓐ Ⓑ Ⓒ ●
14 Ⓐ Ⓑ ● Ⓓ
15 ● Ⓑ Ⓒ Ⓓ
16 Ⓐ ● Ⓒ Ⓓ
17 Ⓐ Ⓑ Ⓒ ●
18 ● Ⓑ Ⓒ Ⓓ
19 Ⓐ Ⓑ ● Ⓓ
20 Ⓐ Ⓑ ● Ⓓ
21 Ⓐ ● Ⓒ Ⓓ
22 ● Ⓑ Ⓒ Ⓓ
23 Ⓐ Ⓑ ● Ⓓ
24 Ⓐ ● Ⓒ Ⓓ
25 Ⓐ Ⓑ ● Ⓓ
26 Ⓐ ● Ⓒ Ⓓ
27 Ⓐ ● Ⓒ Ⓓ
28 Ⓐ Ⓑ ● Ⓓ
29 ● Ⓑ Ⓒ Ⓓ
30 Ⓐ ● Ⓒ Ⓓ
31 Ⓐ Ⓑ ● Ⓓ
32 Ⓐ ● Ⓒ Ⓓ
33 Ⓐ Ⓑ ● Ⓓ
34 Ⓐ ● Ⓒ Ⓓ
35 Ⓐ Ⓑ ● Ⓓ
36 Ⓐ Ⓑ Ⓒ ●
37 Ⓐ ● Ⓒ Ⓓ
38 ● Ⓑ Ⓒ Ⓓ
39 Ⓐ ● Ⓒ Ⓓ
40 Ⓐ Ⓑ ● Ⓓ

PART B – NUMERICAL RESPONSE

1

7	0		
⊙	⊙	⊙	⊙
⓪	●	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
●	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

2

6	0		
⊙	⊙	⊙	⊙
⓪	●	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
●	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

3

4	0		
⊙	⊙	⊙	⊙
⓪	●	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
●	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

4

4	0		
⊙	⊙	⊙	⊙
⓪	●	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
●	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

5

8	0		
⊙	⊙	⊙	⊙
⓪	●	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
●	⑧	⑧	⑧
⑨	⑨	⑨	⑨

6

2	1	3	
⊙	⊙	⊙	⊙
⓪	⓪	⓪	⓪
①	●	①	①
●	②	②	②
③	③	●	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

7

1	.	0	
⊙	●	⊙	⊙
⓪	⓪	●	⓪
●	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

8

1	.	0	
⊙	●	⊙	⊙
⓪	⓪	●	⓪
●	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

9

6	.	8	
⊙	●	⊙	⊙
⓪	⓪	⓪	⓪
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
●	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	●	⑧
⑨	⑨	⑨	⑨

10

1	4	8	
⊙	⊙	⊙	⊙
⓪	⓪	⓪	⓪
●	①	①	①
②	②	②	②
③	③	③	③
④	●	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	●	⑧
⑨	⑨	⑨	⑨

11

1	2	0	
⊙	⊙	⊙	⊙
⓪	⓪	●	⓪
●	①	①	①
②	●	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

12

1	5	0	
⊙	⊙	⊙	⊙
⓪	⓪	●	⓪
●	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	●	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

PART B – NUMERICAL RESPONSE CONTINUED

13	14	15	16	17	18
90	6	26	12	54	128
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪●⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	●①①①	①①①①	●①①①
②②②②	②②②②	●②②②	②●②②	②②②②	②●②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④●④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	●⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	●⑥⑥⑥	⑥●⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧●⑧
●⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

19	20	21	22	23	24
44	18	22	100	50	0
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪●●⓪	⓪●⓪⓪	●⓪⓪⓪
①①①①	●①①①	①①①①	●①①①	①①①①	①①①①
②②②②	②②②②	●●②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
●●④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	●⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧●⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

25	26	27	28	29	30
25	50	75	50	9331	20
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪●⓪⓪	⓪⓪⓪⓪	⓪●⓪⓪	⓪⓪⓪⓪	⓪●⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①●	①①①①
●②②②	②②②②	②②②②	②②②②	②②②②	●②②②
③③③③	③③③③	③③③③	③③③③	③●●③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤●⑤⑤	●⑤⑤⑤	⑤●⑤⑤	●⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	●⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	●⑨⑨⑨	⑨⑨⑨⑨

Part C: Written Response (30 marks)

1. a. Sex-linked alleles are found on the X-chromosome, so the parental genotypes look like this:

Normal Male	Heterozygous (carrier) Female
X^HY	X^HX^h

Potential offspring can be shown with a Punnett square.

	X^H	X^h
X^H	X^HX^H	X^HX^h
Y	X^HY	X^hY

The genotypes of the children will be

1/2 homozygous normal
1/4 heterozygous (carrier)
1/4 hemophilic

The phenotypes will be

1/4 normal male
1/2 normal female (1/4 normal, 1/4 carrier)
1/4 hemophilic male **(4 marks)**

b. Hemophilic female children are unlikely because each female child will receive an X-chromosome from the male parent. The male parental X-chromosome is normal and dominant for blood clotting. Female children will either have X^HX^H or X^HX^h genotypes and in either case will not have hemophilia. At least one normal allele will always be present. **(3 marks)**

c. The two parental genotypes that could produce a female hemophilic child are

- X^hY × X^hX^h
  ↑ Male hemophilic ↑ Female hemophilic

	X^h	X^h
X^h	X^hX^h	X^hX^h
Y		

← Female hemophilic children

- X^hY × X^HX^h
  ↑ Hemophilic male ↑ Carrier female

	X^H	X^h
X^h		X^hX^h
Y		

← Female hemophilic child

(3 marks)

2. Since the greatest frequency (32) is between W and Y, these genes are furthest apart.

W ← 32 → Y

Next closest is X to Y, which is 27 units, and X to W, which is 5 units. This places X in between W and Y.

W ← 5 → X ← 27 → Y

This is possible as 5 + 27 = 32.

Z is 24 units from W and 8 units from Y and 19 units from X.

W ← 24 → Z ← 8 → Y

W ← 5 → X ← 19 → Z ← 8 → Y

This is possible as 24 + 8 = 32.

The likely sequence is WXZY. **(5 marks)**

The map distance is 1 – 5 – 24 – 32. **(5 marks)**

1 → 5 (X)
1 → 24 (Z)
1 → 32 (Y)

3. Amino acids in protein have been converted to three-letter abbreviations. Controls are added to mRNA and DNA.

Protein: glu – ala – cys – cys – gly – leu – pro – lys

glu – ala – cys – cys – gly – leu – pro – lys
↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑

translation {
tRNA CUU – CGA – ACA – ACA – CCU – AAU – GGU – UUU

mRNA AUG – GAA – GCU – UGU – UGU – GGA – UUA – CCA – AAA – UAA

transcription {
initiator (AUG ↑, TAC ↓) terminator (UAA ↑, ATT ↓)

DNA – TAC – CTT – CGA – ACA – ACA – CCT – AAT – GGT – TTT – ATT

(5 marks)

4. a. Grass will affect the badger and hawk populations through the population of ground squirrels. If grass decreases due to less precipitation or overconsumption by ground squirrels, the ground squirrel population will decrease. This will cause badger and hawk populations to decrease. When grass is plentiful, ground squirrels will be plentiful and badgers and hawks will increase. All consumers will increase up to the carrying capacity of the environment. **(1 mark)**

b. Hawks and badgers consume ground squirrels. If hawk and badger populations increase, consumption of ground squirrels will increase. The ground squirrel population will decrease. Less grass will be consumed and grass will increase to the limit of space and moisture. A decrease in hawks and badgers would allow ground squirrels to increase. Consumption of grass may be increased. Eventually overgrazing may occur reducing available grass. **(1 mark)**

c. A drastic reduction in ground squirrels occurred in year 7. This allowed grass to increase but caused a decrease in available food for hawks and badgers and suppressed their populations. **(1 mark)**

d. The populations are K-selected because the environment is relatively stable. The populations increase to a carrying capacity and stabilize, fluctuating together. Two populations, hawks and badgers, have relatively low reproductive rates. All four populations may respond to intraspecific competition such as crowding. **(2 marks)**

BIOLOGY 30

FINAL TEST

GENERAL INSTRUCTIONS

YOU HAVE **TWO-AND-ONE-HALF** HOURS TO COMPLETE THIS TEST. Work through the entire test answering the questions you are sure you know. You will then be able to concentrate on the questions of which you are not quite sure.

TOTAL MARKS: 100

PART A: Multiple Choice	40 marks
PART B: Numerical Response	30 marks
PART C: Written Response	30 marks

BIOLOGY 30 INFORMATION SHEET

Abbreviations for Amino Acids and Nitrogen Bases

Amino Acid	Abbreviation
Alanine	Ala
Arginine	Arg
Asparagine	Asn
Aspartate	Asp
Cysteine	Cys
Glutamate	Glu
Glutamine	Gln
Glycine	Gly
Histidine	His
Isoleucine	Ile
Leucine	Leu
Lysine	Lys
Methionine	Met
Phenylalanine	Phe
Proline	Pro
Serine	Ser
Threonine	Thr
Tryptophan	Trp
Tyrosine	Tyr
Valine	Val

Nitrogen Base	Abbreviation
Adenine	A
Cytosine	C
Guanine	G
Thymine	T
Uracil	U

Abbreviations for Some Hormones

Hormone	Abbreviation
Antidiuretic hormone	ADH
Adrenocorticotropin hormone	ACTH
Follicle-stimulating hormone	FSH
Luteinizing hormone	LH (formerly ICSH)
Prolactin	PRL
Parathyroid hormone	PTH
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid-stimulating hormone	TSH

Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{V}$ or $D_p = \frac{N}{A}$ or $D = \frac{N}{S}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Population growth (%)	$PG\,\% = \frac{\Delta N \times 100\%}{N}$

Value

PART A: MULTIPLE CHOICE

40

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided at the end of Part A and fill in the circle that corresponds to your choice.

Example

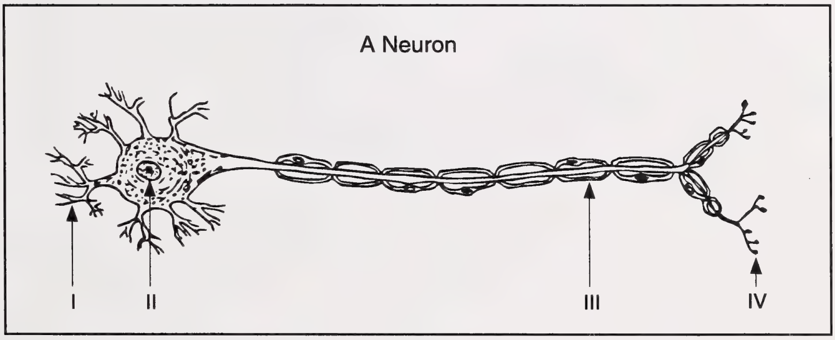
This examination is for the subject of

A. biology
B. physics
C. chemistry
D. mathematics

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Use the following diagram to answer questions 1 to 4.



A Neuron

1. Acetylcholine is produced at

A. I
B. II
C. III
D. IV

2. Cholinesterase is produced at

A. I
B. II
C. III
D. IV

3. A structure which increases the rate of transmission is

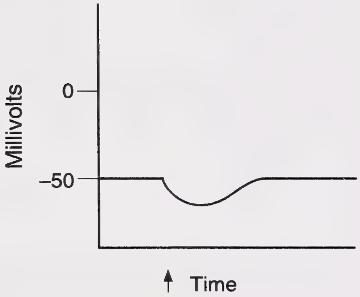
A. I
B. II
C. III
D. IV

4. Genetic mutation of this neuron could occur at

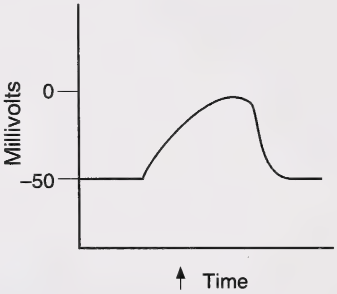
A. I
B. II
C. III
D. IV

5. Consider an intracellular electrode that records the resting potential for a given neuron at –50 millivolts. Which of the following graphs best portrays that an inhibitory neurotransmitter substance has been applied to the neuron? (The arrows indicate time of application.)

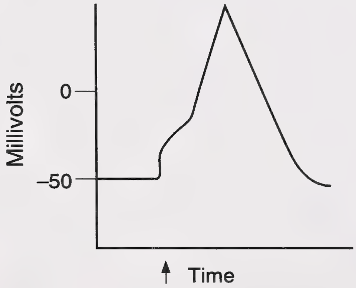
A.



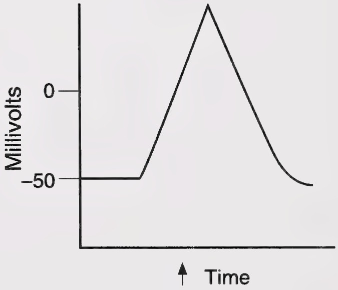
B.



C.



D.



6. Autonomic nervous control is one of the functions of the

A. cerebellum
B. parietal lobe
C. pons
D. medulla

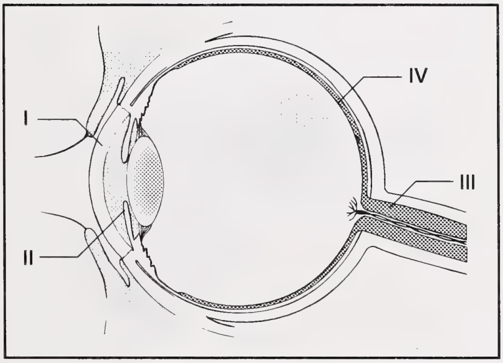
7. Which one of the following functions is not controlled by the sympathetic nervous system?

   A. acceleration of heart rate
   B. decrease in peristalsis by intestine
   C. dilation intestinal capillaries
   D. dilation of capillaries in some skeletal muscles

8. A powerful insecticide causes death by producing convulsive muscular contractions. A simple explanation is that it functions to inhibit the action of

   A. acetylcholine
   B. adrenaline
   C. cholinesterase
   D. epinephrine

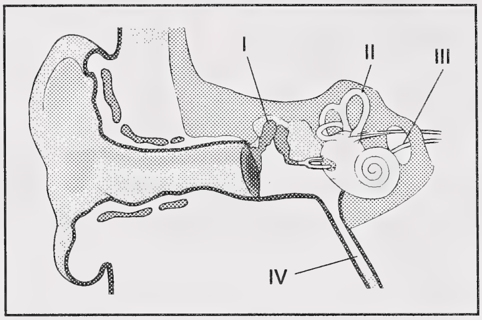
Use the following diagram to answer question 9.



9. The structure of the eye under autonomic nervous control is

   A. I
   B. II
   C. III
   D. IV

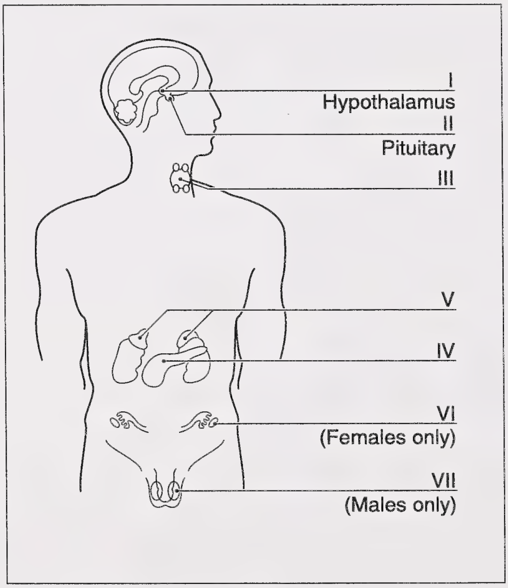
Use the following diagram to answer question 10.



10. The structure in the ear that converts sound waves into mechanical motion is

A. I
B. II
C. III
D. IV

Use the following diagram to answer questions 11 to 20.



11. The pituitary gland produces ACTH which stimulates

A. III
B. IV
C. V
D. VI

12. ADH or antidiuretic hormone is synthesized in

    A. I
    B. II
    C. III
    D. IV

13. The stress hormone epinephrine is produced by

    A. II
    B. III
    C. IV
    D. V

14. A gland which has both endocrine and exocrine functions is

    A. II
    B. III
    C. IV
    D. V

15. Low secretion of growth hormone may be caused by dysfunction of gland

    A. II
    B. III
    C. IV
    D. V

16. The islets of Langerhans are specialized cells in gland

    A. III
    B. IV
    C. V
    D. VI

17. Testosterone is produced by

    A. II
    B. III
    C. V
    D. VII

18. Testosterone levels exert negative feedback on gland

    A. I
    B. II
    C. III
    D. IV

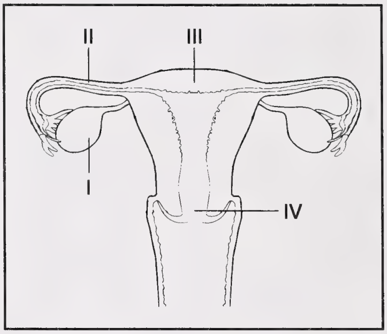
19. LH from gland II stimulates ovulation in gland

A. IV
B. V
C. VI
D. VII

20. Inadequate amounts of iodine in the diet can cause an enlargement of gland

A. I
B. II
C. III
D. IV

Use the diagram at the right to answer questions 21 to 24.



21. Meiosis II occurs in structure

A. I
B. II
C. III
D. IV

22. A corpus luteum would be found in structure

A. I
B. II
C. III
D. IV

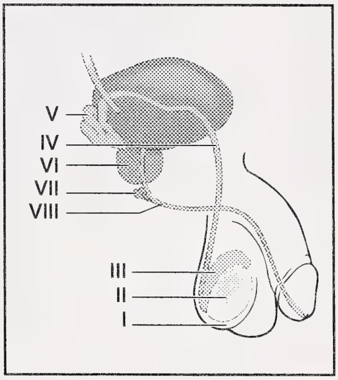
23. Progesterone stimulates development at

A. I
B. II
C. III
D. IV

24. An ectopic pregnancy would result if implantation occurred at

A. I
B. II
C. III
D. IV

Use the diagram at the right to answer questions 25 to 28.



25. Sperm may be stored prior to release at site

A. I
B. II
C. III
D. IV

26. Cancer is quite common in males in gland

A. V
B. VI
C. VII
D. VIII

27. Sertoli cells are found in

A. I
B. II
C. III
D. IV

28. In a vasectomy the following structure is severed

A. II
B. III
C. IV
D. VIII

29. Double-stranded chromosomes form in

A. interphase
B. prophase
C. metaphase
D. anaphase

30. Crossing-over of segments of chromatids occurs most frequently in

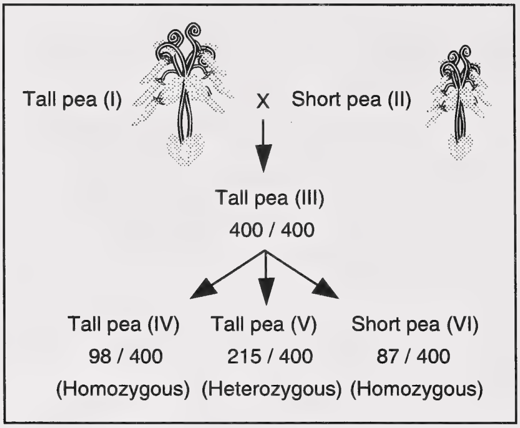
A. interphase
B. prophase
C. anaphase
D. telophase

31. Nondisjunction is a potentially serious disorder characterized by

A. large amounts of crossing-over in meiosis
B. delayed implantation of the zygote
C. failure of chromosomes to separate in meiosis
D. translocation of entire chromosome segments

Gregor Mendel crossed pea plants in a method similar to this illustration.

Use this lineage to answer questions 32 to 35.



32. The phenotype of the F_1 generation is

    A. short
    B. tall
    C. homozygous
    D. recessive

33. The genotype of the F_1 generation is

    A. homozygous dominant
    B. homozygous recessive
    C. heterozygous
    D. not obvious here

34. The phenotypic ratio of the F_2 generation is approximately

    A. 1:1
    B. 3:1
    C. 1:2:1
    D. 2:1

35. The genotype of plant V would be similar to plant

    A. I
    B. II
    C. III
    D. IV

36. A red tall flower is crossed with a white short flower. Red and tall are dominant alleles. Both plants are completely homozygous. The expected phenotype(s) of the F_1 generation will be

A. 2/3 red tall : 1/3 white short
B. 1/4 red tall : 1/4 red short : 1/4 white tall : 1/4 white short
C. 1/2 red tall : 1/2 white short
D. all red tall

37. Intraspecific competition could be competition between

A. a male white-tailed deer and a male mule deer
B. two herds of white-tailed deer in a field
C. caribou and timber wolves
D. humans and caribou for a forest resource

38. In the Hardy-Weinberg equation, $p^2 + 2pq + q^2 = 1$, p refers to

A. the frequency of the dominant allele
B. the size of the population
C. the probability of mutation
D. the variation expected among phenotypes

39. In the population formula $R = \frac{\Delta D}{\Delta t}$ where t is constant, a change in the number of organisms per square kilometre by emigration will

A. cause an increase in R
B. cause a decrease in R
C. cause an increase in D
D. have virtually no effect on R because t is constant

40. K-selected populations are characterized by

A. unstable environmental conditions
B. high birth rates
C. intense intraspecific competition
D. short life spans

BIOLOGY 30 FINAL TEST ANSWER SHEET

PART A – MULTIPLE CHOICE

1 Ⓐ Ⓑ Ⓒ Ⓓ
2 Ⓐ Ⓑ Ⓒ Ⓓ
3 Ⓐ Ⓑ Ⓒ Ⓓ
4 Ⓐ Ⓑ Ⓒ Ⓓ
5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ
7 Ⓐ Ⓑ Ⓒ Ⓓ
8 Ⓐ Ⓑ Ⓒ Ⓓ
9 Ⓐ Ⓑ Ⓒ Ⓓ
10 Ⓐ Ⓑ Ⓒ Ⓓ
11 Ⓐ Ⓑ Ⓒ Ⓓ
12 Ⓐ Ⓑ Ⓒ Ⓓ
13 Ⓐ Ⓑ Ⓒ Ⓓ
14 Ⓐ Ⓑ Ⓒ Ⓓ
15 Ⓐ Ⓑ Ⓒ Ⓓ
16 Ⓐ Ⓑ Ⓒ Ⓓ
17 Ⓐ Ⓑ Ⓒ Ⓓ
18 Ⓐ Ⓑ Ⓒ Ⓓ
19 Ⓐ Ⓑ Ⓒ Ⓓ
20 Ⓐ Ⓑ Ⓒ Ⓓ
21 Ⓐ Ⓑ Ⓒ Ⓓ
22 Ⓐ Ⓑ Ⓒ Ⓓ
23 Ⓐ Ⓑ Ⓒ Ⓓ
24 Ⓐ Ⓑ Ⓒ Ⓓ
25 Ⓐ Ⓑ Ⓒ Ⓓ
26 Ⓐ Ⓑ Ⓒ Ⓓ
27 Ⓐ Ⓑ Ⓒ Ⓓ
28 Ⓐ Ⓑ Ⓒ Ⓓ
29 Ⓐ Ⓑ Ⓒ Ⓓ
30 Ⓐ Ⓑ Ⓒ Ⓓ
31 Ⓐ Ⓑ Ⓒ Ⓓ
32 Ⓐ Ⓑ Ⓒ Ⓓ
33 Ⓐ Ⓑ Ⓒ Ⓓ
34 Ⓐ Ⓑ Ⓒ Ⓓ
35 Ⓐ Ⓑ Ⓒ Ⓓ
36 Ⓐ Ⓑ Ⓒ Ⓓ
37 Ⓐ Ⓑ Ⓒ Ⓓ
38 Ⓐ Ⓑ Ⓒ Ⓓ
39 Ⓐ Ⓑ Ⓒ Ⓓ
40 Ⓐ Ⓑ Ⓒ Ⓓ

Name of Student ______________________ Student I.D. # ______________

Name of School ______________________ Date ______________

Value

PART B: NUMERICAL RESPONSE

30

- Record your answer on the answer sheet provided at the end of Part B by writing it in the boxes and then filling in the corresponding circles.

- Numerical-response questions may require answers consisting of only one, two, or three digits. In these cases, enter the first digit of your answer in the **left-hand box** on the answer sheet and leave any unused boxes blank.

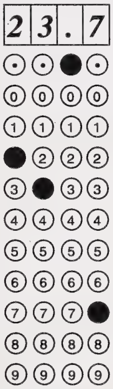
- If an answer is a value between 0 and 1 (e.g. 0.25), then be sure to record the 0 before the decimal place.

Sample Calculation Question and Solution

The average of the values 21, 25.5, and 24.5 is ________ .
(Record your answer to three digits.)

$$\begin{aligned} \text{Average} &= (21 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7\,(\text{rounded to three digits}) \end{aligned}$$

Record 23.7 on the answer sheet ⟶



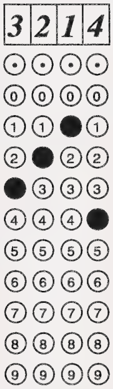
Sample Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is ________.
(Record all four digits.)

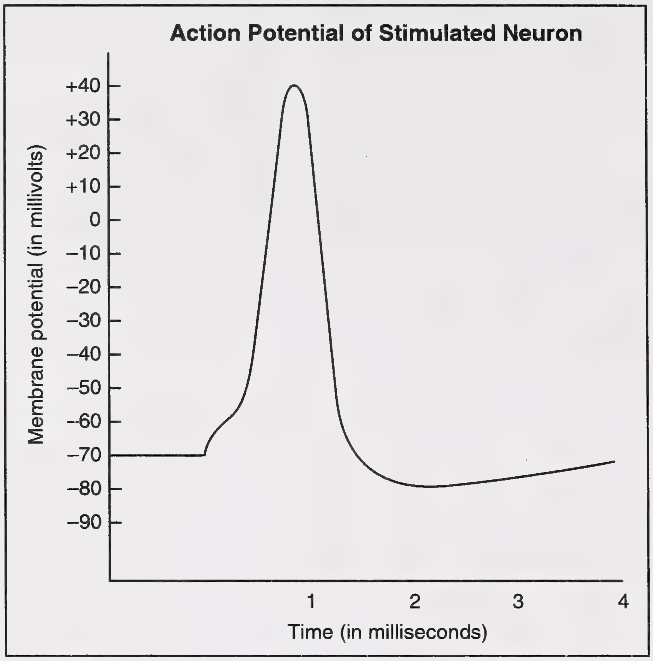
1. mathematics
2. chemistry
3. biology
4. physics

Answer 3, 2, 1, 4

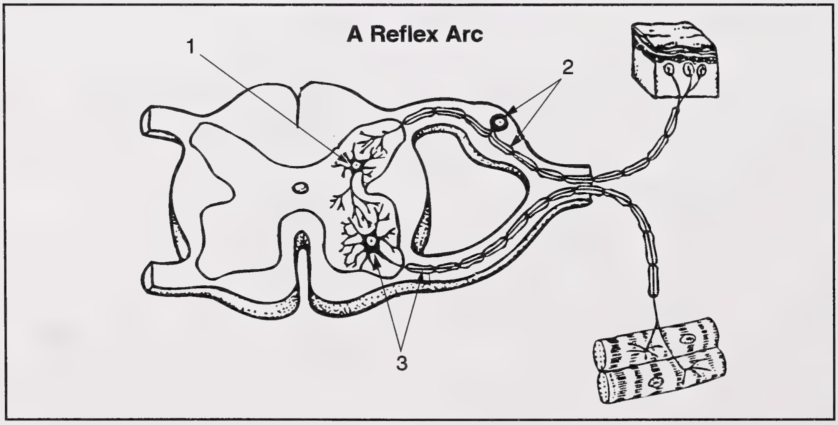
Record 3214 on the answer sheet ⟶



Use the following graph of an action potential to answer numerical response questions 1 to 5.
Positive (+) and negative (–) signs do not have to be indicated in your answers.



1. Indicate the membrane potential at rest.
2. Indicate the membrane potential where the Na^+ gates open in the membrane.
3. Indicate the voltage of the totally depolarized membrane.
4. Indicate the voltage where Na^+ no longer diffuses through the membrane but K^+ begins diffusion.
5. Indicate the maximum membrane potential during the refractory period.
6. Indicate the order of depolarization in the reflex arc in this diagram.



Use the following table to answer questions 7 to 9.

Subject	Glucose in Urine	Protein in Urine	Urine Output L/day
A Normal	0.0	0.0	2.2
B	0.1	0.0	4.1
C	0.0	2.0	6.8
D	0.0	0.0	1.0

7. Record the urine output for a person who is somewhat dehydrated from exhaustive exercise.

8. Indicate the urine output for a person with the highest level of ADH.

9. Indicate the urine output for the person with the lowest level of ADH.

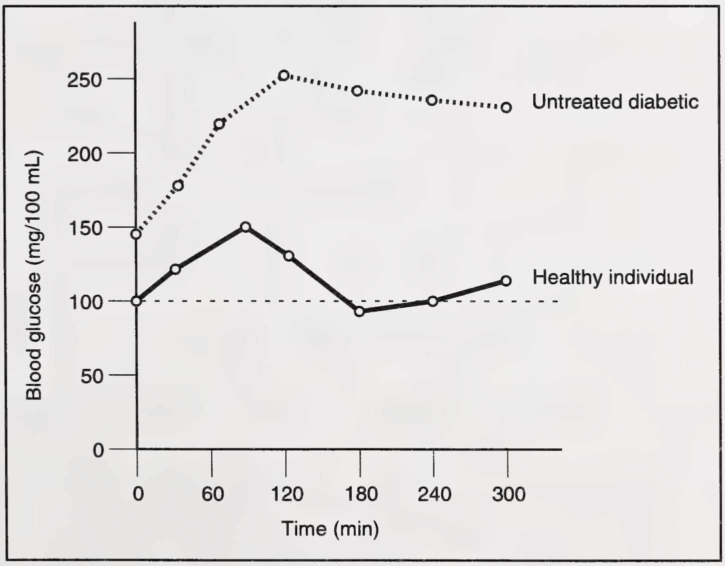
Use the following table to answer questions 10 and 11.

Aldosterone	Na^+ in Plasma	Blood Pressure
normal	142	normal
w	120	x
y	148	z

10. Indicate the sodium level that would be associated with high blood pressure.

11. Indicate the sodium level that may be caused by low aldosterone secretion.

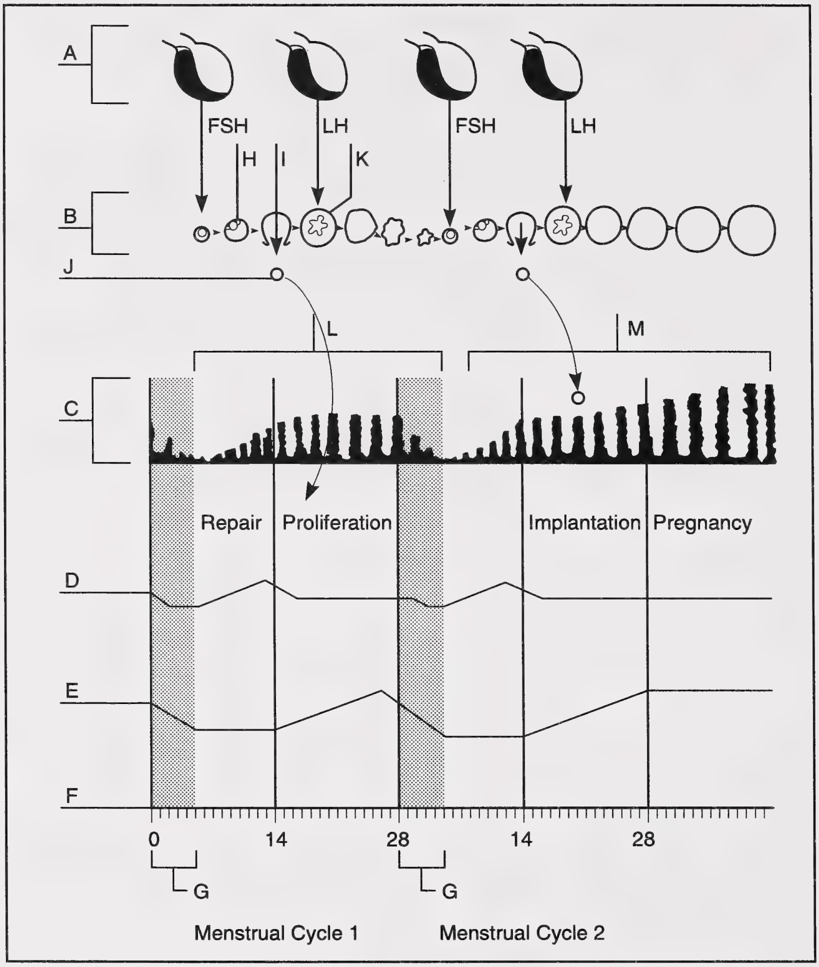
Use the following graph to answer questions 12 and 13.



12. Indicate the blood glucose value of the healthy individual 90 min after ingesting glucose.

13. How many minutes were required for the healthy individual to store the ingested glucose in the liver?

Use this figure to answer questions 14 to 16.



A. Pituitary gland
B. Development of Graafian follicle and corpus luteum in ovary
C. Wall of uterus
D. Estrogen level
E. Progesterone level
F. Time in days
G. Menstruation
H. Graafian follicle
I. Ovulation
J. Ovum
K. Corpus luteum
L. Ovulation without fertilization
M. Ovulation with fertilization

14. How many days are required for the ovum to travel from the follicle to the endometrium?

15. On what day in the second cycle should progesterone levels have started to fall but didn't because of pregnancy?

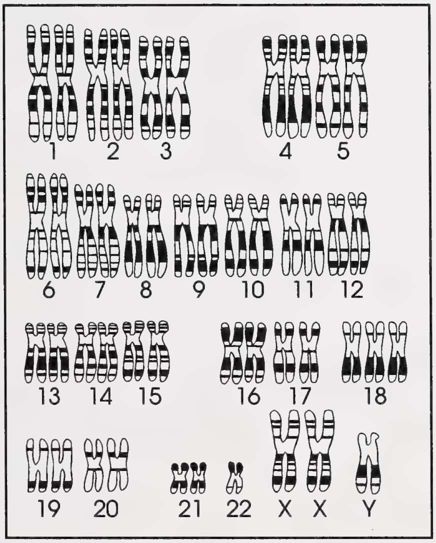
16. On what day did estrogen peak in the second cycle?

17. If an organism has a 2n number of 54, how many chromosomes would be found in each of its cells in mitotic interphase?

18. If an organism has a 2n number of 256, how many chromosomes would be expected in a normal gamete of this organism?

19. Experiencing nondisjunction, a sperm short of one chromosome fertilizes a normal ovum. The resulting zygote has 87 chromosomes. What is the normal n number for this organism?

Use this karyotype to answer questions 20 and 21.



20. Which chromosome number indicates trisomy?

21. Which chromosome number indicates monosomy?

22. In a monohybrid cross between a homozygous dominant parent and a heterozygous parent, what percentage of the offspring would carry the dominant allele?

23. In the cross described in question 22, what percentage of offspring would be heterozygous?

24. In the cross described in question 22, what percentage of the offspring would be homozygous recessive?

Consider a monohybrid cross between two heterozygous parents for questions 25 to 28.

25. What percentage of offspring would be homozygous dominant?

26. What percentage of the offspring would be heterozygous?

27. What percentage of offspring would show the dominant phenotype?

28. What percentage of offspring is genotypically identical to the parents?

29. In a dihybrid cross of heterozygous parents *AaBb* × *AaBb*, what will be the expected ratio of phenotypes in the F_1 generation?

30. If 320 offspring are produced by the cross described in question 29, how many will be completely homozygous recessive?

PART B – NUMERICAL RESPONSE

1	2	3	4	5	6
☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①①	①①①①
②②②②	②②②②	②②②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

7	8	9	10	11	12
☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①①	①①①①
②②②②	②②②②	②②②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

13	14	15	16	17	18
☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①①	①①①①
②②②②	②②②②	②②②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

Name of Student ______________________ Student I.D. # ______________

Name of School ______________________ Date ______________

PART B – NUMERICAL RESPONSE CONTINUED

19	20	21	22	23	24
☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①①	①①①①
②②②②	②②②②	②②②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

25	26	27	28	29	30
☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐
⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙	⊙⊙⊙⊙
⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪	⓪⓪⓪⓪
①①①①	①①①①	①①①①	①①①①	①①①①	①①①①
②②②②	②②②②	②②②②	②②②②	②②②②	②②②②
③③③③	③③③③	③③③③	③③③③	③③③③	③③③③
④④④④	④④④④	④④④④	④④④④	④④④④	④④④④
⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤	⑤⑤⑤⑤
⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥	⑥⑥⑥⑥
⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦	⑦⑦⑦⑦
⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧	⑧⑧⑧⑧
⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨	⑨⑨⑨⑨

Name of Student ______________________ Student I.D. # ______________

Name of School ______________________ Date ______________

Value

PART C: WRITTEN RESPONSE

30

- Read the questions carefully.
- Write your answers in the examination booklet as neatly as possible.
- Communicate your answers in clear, complete sentences. Sketches and/or diagrams may be used to support the pertinent explanations.

(10 marks) 1. Let *H* indicate a normal allele for blood clotting and *h* indicate the allele for hemophilia, a sex-linked disease.

a. If a normal male and a heterozygous female (carrier) have children, describe and illustrate all of the possible genotypes and phenotypes for this gene. **(4 marks)**

b. Explain why hemophilic female children are unlikely in this family. **(3 marks)**

Name of Student ______________________	Student I.D. # ______________
Name of School ______________________	Date ______________

c. Describe two parental genotypes that could produce a female hemophilic child. Illustrate your answer. **(3 marks)**

(10 marks) 2. In a series of breeding experiments, linkage of genes by crossover frequency was determined as follows. Construct a gene map using these frequencies and indicate the distances between each gene in map units.

Table of Gene Crossover Frequencies

Genes	W	X	Y	Z
W	–	5	32	24
X	5	–	27	19
Y	32	27	–	8
Z	24	19	8	–

Name of Student ______________________ Student I.D. # ______________

Name of School ______________________ Date ______________

(5 marks)

3. Using the amino acids and RNA codons from the following table, construct the tRNA, mRNA, and DNA nucleotide sequence for the following protein. Show where transcription and translation occurs. Include controls. In cases where more than one mRNA codon exists for an amino acid, use the first codon from the table.

Table of Messenger RNA Code Words

Amino acids	Codons
Alanine	GCU GCC GCA GCG
Arginine	CGA CGU CGC CGG AGA AGG
Asparagine	AAU AAC
Aspartate	GAU GAC
Cysteine	UGU UGC
Glutamate	GAA GAG
Glutamine	CAG CAA
Glycine	GGA GGC GGU GGG
Histidine	CAU CAC
Isoleucine	AUC AUU AUA
Leucine	UUA UUG CUU CUC CUA CUG
Lysine	AAA AAG
Methionine	AUG
Phenylalanine	UUU UUC
Proline	CCA CCC CCU CCG
Serine	UCG UCU UCA UCC AGU AGC
Threonine	ACU ACC ACG ACA
Tryptophan	UGG
Tyrosine	UAU UAC
Valine	GUU GUC GUA GUG
Terminator	UAA UAG UGA
Initiator	AUG

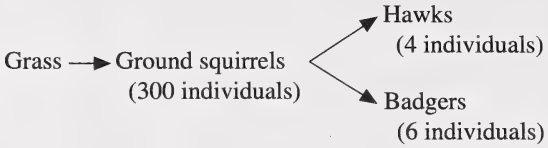
Protein:
glutamate – alanine – cysteine – cysteine – glycine – leucine – proline – lysine

Answer:

Name of Student	__________	Student I.D. #	__________
Name of School	__________	Date	__________

(5 marks)

4. When a small farm is abandoned, a field of grass is invaded by Richardson ground squirrels, badgers, and red-tailed hawks. A food web is established as follows



The grass varies mostly according to precipitation and consumption by ground squirrels. The following table shows population dynamics over twelve years.

Populations in Abandoned Field over 12 Years

Year	Ground Squirrels	Badgers	Hawks
0	0	0	0
1	40	1	2
2	100	0	2
3	200	2	4
4	300	5	4
5	240	4	2
6	280	6	3
7	90	?	?
8	260	4	2
9	310	6	4
10	280	5	3
11	280	6	4
12	?	2	?

a. Describe how the grass will influence the hawk and badger populations.

Name of Student ____________________ Student I.D. # ____________________

Name of School ____________________ Date ____________________

b. Describe how the hawk and badger populations will influence the grass.

c. In one particular year, disease drastically reduced the ground squirrel population. Identify this year and speculate on the effect of this event on the grass, badgers, and hawks.

d. Decide and discuss whether the organisms in the the field are r-selected or K-selected.

Name of Student ______________________ Student I.D. # ______________

Name of School ______________________ Date ______________

TEACHER QUESTIONNAIRE FOR BIOLOGY 30

This is a course designed in a new distance-learning format, so we are interested in your responses. Your constructive comments will be greatly appreciated so that a future revision may incorporate any necessary improvements.

Teacher's Name ______________________ Area of Expertise ______________________

School Name ______________________ Date ______________________

Design

1. The modules follow a definite systematic design. Did you find it easy to follow?

   ☐ Yes ☐ No If no, explain.

   ____

   ____

2. Did your observations reveal that the students found the design easy to follow?

   ☐ Yes ☐ No If no, explain.

   ____

   ____

3. Did you find the Learning Facilitator's Manual helpful?

   ☐ Yes ☐ No If no, explain.

   ____

   ____

4. Part of the design involves stating the objectives in student terms. Do you feel this helped the students understand what they were going to learn?

   ☐ Yes ☐ No If no, explain.

   ____

   ____

5. The Learning Facilitator's Manual contains Assignment answers and a sample test. Did you find these helpful?

☐ Yes ☐ No If no, explain.

6. Did the Follow-up Activities prove to be helpful?

☐ Yes ☐ No If no, explain.

7. Were students motivated to try these Follow-up Activities?

☐ Yes ☐ No If no, give details.

8. Suggestions for computer and video activities are included in the course. Were your students able to use these activities?

☐ Yes ☐ No Comment on the lines below.

9. Were the assignments appropriate?

☐ Yes ☐ No If no, give details.

10. Did you fax assignments? ☐ Yes ☐ No

11. If you did fax, did you get satisfactory results from using this procedure?

☐ Yes ☐ No If no, give details.

Instruction

1. Did you find the instruction clear?

☐ Yes ☐ No If no, give details.

____

____

2. Did your observations reveal that the students found the instruction interesting?

☐ Yes ☐ No If no, give details.

____

____

3. Did you find the instruction adequate?

☐ Yes ☐ No If no, give details.

____

____

4. Was the reading level appropriate?

☐ Yes ☐ No If no, give details.

____

____

5. Was the work load adequate?

☐ Yes ☐ No If no, give details.

____

____

6. Was the content accurate and current?

☐ Yes ☐ No If no, give details.

____

____

7. Did the content flow consistently and logically?

☐ Yes ☐ No If no, give details.

8. Was the transition between booklets smooth?

☐ Yes ☐ No If no, give details.

9. Was the transition between print and media smooth?

☐ Yes ☐ No If no, give details.

Additional Comments

Thanks for taking the time to complete
this survey. Your feedback is important
to us.

Fax Number: 674-6686

Instructional Design and Development Unit
Alberta Distance Learning Centre
Box 4000
Barrhead, Alberta
T0G 2P0

Note: Please ensure that each of your students has completed and forwarded a copy of the Course Survey.

N.L.C./B.N.C.
3 3286 50153 8157

Biology 30

Learning Facilitator's
Manual

L.R.D.C.
Producer 1994